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AN ANALYSIS OF THE 1977 AD/AR TARSLL.(U)
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NAVAL POSTGRADUATE SCHOOL

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THESIS

AN ANALYSIS OF THE 1977 AD/AR TARSLL.

by

James Wiley Hargrove, Jr.

September 1980

Thesis Advisor F. R. Richards

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A094	3. RECIPIENT'S CATALOG NUMBER 616
4. TITLE (and Subtitle) An Analysis of the 1977 AD/AR TARSLL		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; September 1980
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) James Wiley Hargrove, Jr.		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE September 1980
		13. NUMBER OF PAGES 96
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Inventory Model TARSLL

Load List

Accession For
NTIS GRA&I ☑
DTIC TAB ☐
Unannounced ☐
Justification
By
Distribution/
Availability Codes
Dist Avail and/or Special
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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(Page 1) S/N 0102-014-6601

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. (continued)

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An Analysis of the 1977 AD/AR TARSLL

by

James Wiley Hargrove, Jr.
Lieutenant Commander, Supply Corps,
United States Navy
B.S., Georgia Institute of Technology, 1970

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
September 1980

Author: James W. Hargrove, Jr.

Approved by: F R Richards
Thesis Advisor

Joel R. Sartore
Second Reader

Chairman, Department of Opertions Reasearch

W M Woods
Dean of Information and Policy Sciences

ABSTRACT

The industrial mission of Destroyer Tenders (AD) and Repair Ships (AR) is to provide intermediate level maintenance and repair for supported ships. The Tender and Repair Ship Load List for these ships (AD/AR TARSLL) designates the range (number) and depth (quantity) of repair parts to be carried to support this industrial mission. This thesis details the logical reasoning and mathematical theory used to develop the 1977 AD/AR TARSLL, including an analysis of the data development, the mathematical inventory model and procedures used, and various assumptions and constraints applied during the process. Actual demand history for the six AD/AR's in the Atlantic fleet for a two year period from 1977 to 1979 was used to evaluate the effectiveness of the load list. The effects of certain assumptions in the model on the load list were analyzed. The proposed changes for the 1980 TARSLL were incorporated in the 1977 TARSLL and evaluated. Also, alternative models and methods of load list development were proposed and evaluated.

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I. GENERAL BACKGROUND AND INTRODUCTION

A. DEFINITION AND PURPOSE OF THE TARSLL

The industrial mission of Destroyer Tenders (AD) and Repair Ships (AR) is to provide intermediate level maintenance and repair for supported ships. The Tender and Repair Ship Load List for these ships (AD/AR TARSLL) designates the range (number) and depth (quantity) of repair parts to be carried to support this industrial mission for a specific period of time. A separate load list is developed for the Atlantic and Pacific fleets. Each Destroyer Tender or Repair Ship in the same fleet carries the same load of items. This load has been designated as Prepositioned War Reserve Stock (PWRS) by the Chief of Naval Operations (CNO) and as such is not only to be responsive to peacetime demands but also to satisfy wartime requirements. The normal support period is therefore specified as ninety (90) days since this is considered the required support period for a wartime environment without resupply. The CNO has also set an 85 percent net requisition effectiveness goal for the AD/AR TARSLL. This means that 85 percent of all of the requisitions submitted in a 90 day period for items carried by the TARSLL should be completely filled from stock. This excludes requisitions from supported ships for resupply of their stock since the TARSLL is not designed to support this. A new TARSLL is produced about every three years. Prior to 1979 the Fleet Material Support Office (FMSO) was responsible for development of the TARSLL model and production of the actual load list. The production function is now the responsibility of the Ship's Parts Control Center (SPCC).

B. PROBLEMS WITH THE 1977 AD/AR TARSLL

The AD/AR TARSLL developed in 1977 for the Atlantic fleet had a per ship range of about 13,000 different line items and a per ship value over $750,000. In August 1979 the Commander Naval Surface Force Atlantic Fleet (the type commander for Atlantic fleet tenders and repair ships) critized the 1977 AD/AR TARSLL for not being responsive to fleet needs. In particular he claimed that over 9000 of the load list items had no demand for two years. The current model is about 16 years old and has not undergone a complete analytic review since inception, although there have been several interim changes to correct apparent deficiencies. Some people involved in the development of the 1980 TARSLL at SPCC have recommended several changes in the methodology and parameters used in the model prior to development of the 1980 TARSLL. The more important changes concern the criteria for determining the range of items to be carried, the essentiality of items, and the average quarterly demand for items without a demand history. FMSO has been tasked by the Naval Supply Systems Command (NAVSUP) to review the AD/AR TARSLL development process and recommend procedural changes for the 1980 load list.

C. THESIS PURPOSE

The purpose of this thesis is to detail the logical reasoning and mathematical theory used to develop the 1977 AD/AR TARSLL, including an analysis of the data development, the mathematical inventory model and procedures used, and various assumptions and constraints applied during the process. Actual demand history for the six AD/AR's in the Atlantic fleet for a two year period from 1977 to 1979 will be used to evaluate the effectiveness of the load list. The effects of certain assumptions in the model on the load list will be analyzed. The proposed changes for the 1980 TARSLL

will be incorporated in the 1977 TARSLL and evaluated. Also, alternative models and methods of load list development will be proposed and evaluated. The scope of this thesis has been coordinated with FMSO to support their efforts in improving the 1980 AD/AR TARSLL.

II. GENERAL DESCRIPTION OF TARSLL DEVELOPMENT

A. GENERAL DESCRIPTION OF THE INVENTORY

There are two distinct categories of items considered in the development of the TARSLL. The first category is equipment related (ER) items which are load list candidates based on their identification to an equipment or component to be supported by the tender's repair capability. The other category is non-equipment related (NER) items which are load list candidates based on demand. If an item does not meet the criteria to be an ER candidate, but does have industrial demand reported in the last two years by a tender or repair ship to be supported by the load list, then this item is designated an NER candidate.

B. EQUIPMENT SUPPORT DETERMINATION

The first step in determining the ER candidate items is to list the ships by hull type and number to be supported by the tenders and repair ships of each fleet. This is called the hull mix. Once it is established, SPCC retrieves from its master files all Allowance Parts Lists (APL's) applicable to the hull mix. These APL's are then filtered through a component cut which basically eliminates from further consideration any APL's that are not applicable to at least seven ships in the hull mix. Of course the type commander can override the component cut for any APL. The repair parts appearing on the candidate APL's are then screened to eliminate those items that cannot be installed at the tender or repair ship level. The remaining items, plus any other identified by the type commander, become the ER candidate repair parts. During this last screening, the total quantity of each item installed in the supported ships is accumulated along with the lowest level at which the item

can be installed, i.e. either the load activity or the supported ship. Once the ER candidate items are identified, the SPCC master data files are entered to obtain additional information about the item, including price, minimum replacement quantity, and Best Replacement Factor (BRF). The meaning and use of the BRF will be explained later.

C. INPUT DEVELOPMENT

The next step is the retrieval of the historical demand data for these items. Destroyer Tenders and Repair Ships are a part of the Mobile Logistic Support Force (MLSF) and as such are required to report their parts demand monthly to SPCC. SPCC retains this data for 24 months on the MLSF demand file. In the retrieval process the 24 months of demand history for each item is summarized as eight quarters of demand quantity (number of units demanded) and demand frequency (number of times demanded). Only those demands identified for use in support of the tender or repair ship's industrial mission are extracted from the MLSF demand file. Additionally those items on the demand file that did not qualify as ER candidates are classified as NER candidates and their demand history is summarized as was done for the ER candidates.

D. RANGE AND DEPTH DETERMINATION

To determine the variety of items to be stocked, the model applies a range cut; that is, any item that has anticipated demand in the next two years greater than a specific level (the range cut parameter) will be stocked, and any item with anticipated demand less than the range cut parameter will not be stocked, subject of course to individual item quantity overrides. The range cut really determines the line items to be carried on the TARSLL, while all other calculations only determine the depth to be stocked. The range cut criterion is applied to each item as

it is being considered by the model. If an item does not pass the range cut, and is not forced on the load list by an override, the total demand quantity and total frequency of demand are accumulated, and then the next candidate is considered. If an item passes the range cut, it proceeds to the depth calculation. The model that is used for depth determination is a variable-protection-level, single-period-constrained, inventory model. The objective function is to minimize the total essentiality-weighted cost of the load, subject to the constraint that requisition effectiveness be at least 85 percent. Essentiality-weighted cost is used in the objective function to provide increased depth for more essential items in a wartime environment. The problem is solved by an iterative process based on a Lagrange multiplier approach. The variable input risk parameter (the Lagrange multiplier) is set and the essentiality-weighted cost equation is solved for the risk factor. The stock level for each item is set by using the risk factor to adjust the predicted demand, which is assumed to be normally distributed, subject to various constraints. After these preliminary stock levels are set, a prediction routine is run to estimate the net requisition effectiveness. If the desired 85 percent effectiveness is achieved, then the TARSLL is set. If the desired effectiveness is not achieved, then a new risk parameter is input and the process is repeated.

E. TARSLL IMPLEMENTATION

Once the load list has been determined by the computer model, a series of listings are output for review by SPCC. These listings allow an analyst to review the load list in several different forms to determine if additional items should be deleted from the TARSLL based on quantity, price, or demand frequency. After these "post model" changes have been made, the financial statistics for the final TARSLL are

forwarded to NAVSUP for approval. Upon approval, a tape with the load list items and all data necessary for requisitioning is provided to each load list carrying activity. There it is merged with other "ship's stock" to determine the quantity to be ordered. Throughout the life of the TARSLL, adjustments can be made by individual ships based on actual demand. Additional items may be stocked if there are four demands in 12 months and additional quantities of a stocked item may be carried if certain quantity and frequency of demand criteria are met.

III. DESCRIPTION OF THE INVENTORY MODEL

The procedure described in this chapter is not the result of the rigorous application of inventory theory. Instead, it has evolved over time through the process of trial and error. There have been many patches made to correct apparent deficiencies in the model, as evidenced by the many overrides and constraints. Consequently, there is no theoretical discussion of the inventory model in the basic documentation for the process. The mathematical model presented later in this chapter, therefore, is necessarily the result of reverse derivation from the mechanics of the procedure. The model was derived to provide some insight into the objectives and basic constraints of the procedure, and should be viewed from this perspective.

A. FORECASTING EXPECTED DEMAND

The first steps toward the determination of the range and depth of items to be carried on the TARSLL are the computations of the average quarterly demand (AQD), the standard deviation of demand (SIGMA), and the average requisition size (A). For items with demand history, AQD is the straight average of the eight quarters of demand. For items without any demand history, the Best Replacement Factor (BRF) for the item and its installed population are used to estimate the average quarterly demand. The BRF for each item is the expected number of times an item will require replacement in one year. Since the BRF is developed based on all usages of the item, it may not reflect the expected replacement rate in the equipments supported by the TARSLL. The following formula is used to determine the average quarterly demand:

$$AQD = 1/4 \; BRF \left[(POPs \times K2) + (POPt \times K3) \right]$$

POPs is the fleet population of the item that is installable at the organizational (shipboard) level;

POPt is the fleet population of the item that is installable at no lower than the tender level;

K2 is the fraction of the item's population installable at the organizational level that is to be supported by the tender;

K3 is the fraction of the item's population that can be installed at the tender level that is to be supported by the tender.

K2 and K3 indicate the probability that the tender or repair ship will see a demand for parts installable at the different levels of maintenance. The value of K2 is set to be 0.1. This means that a tender or repair ship should replace a part installable at the organizational level only 10 percent of the time the part fails. The value of K3 is set at .33 which means that a tender or repair ship should replace a part installable at no lower than the tender level 33 percent of the time. If AQD computes to zero then a value of 0.001 is used. The standard deviation for items with demand history is computed as follows:

$$\text{SIGMA} = \sqrt{\frac{\sum_{i=1}^{8}(D_i - \text{AQD})^2}{8}} \quad ,\text{where}$$

Di is the demand for quarter i.

For items with no demand history SIGMA is taken to be 1.6xAQD if AQD is greater than or equal to 1.0 and 2.1xAQD otherwise. If AQD was forced to be 0.001 then SIGMA is forced to be 0.0001. The average quarterly demand and the standard deviation are then supposed to be factored by the number of ships using the TARSLL to reduce demand data from an ocean level to an individual ship level. In the development of the 1977 TARSLL, however, there was no factoring of either AQD or SIGMA. For items with demand history, the average requisition size, A, is equal to the total demand quantity divided by the total demand frequency. For all other items, A is set to one.

B. RANGE CUT PROCESS

Once the AQD has been predicted, the range of items to be carried can be determined. This is done by the range cut process which is distinct from the depth determination process. If an item has a predicted two-year demand (8xAQD) greater than or equal to the range cut value, the item is stocked. Otherwise, it is not stocked. An item passing the range cut then goes to the depth computation. However, should the computed depth be less than one, the range cut process forces the load-list quantity to be one.

C. DETERMINING ESSENTIALITY

To determine the depth of an item, its essentiality must first be computed. For items without demand history, i.e. demand was estimated by the BRF method, the essentiality factor E is computed by the following equation:

$$E = \frac{POPs \times Ks \times e^{-(116-MECs)ALPHs} + POPt \times Kt \times e^{-(58-MECt)ALPHt}}{POPs + POPt}$$

POPs is the fleet population of the item that is installable at the organizational level;

POPt is the fleet population of the item that is installable at no lower than the tender level;

Ks is a parameter used to weight the applications installable at the organizational level (value $\leq$ 1);

Kt is a parameter used to weight the applications installable at no lower than the tender level (value $\leq$ 1);

MECs is the military essentiality code of those items installable at the organizational level (maximum value is 116);

MECt is the military essentiality code for those items installable at no lower than the tender level (maximum value is 58);

ALPHs is a parameter used to control the range of essentiality for items installable at the organizational level (equals .12);

ALPHt is a parameter used to control the range of essentiality for items installable at no lower than the tender level (equals .12).

Ks and Kt indicate the relative essentiality of parts

installable at the different levels of maintenance. The current values of Ks and Kt are .67 and 1.0 respectively, indicating that parts installable at no lower than the tender level are 50 percent more essential to the tender's repair mission than are parts installable at the organizational level. It should be noted that, in all cases, the value of E computed by the above equation will be less than one. Should E compute to zero, then a default value, which is currently unity, is used. For items that have average quarterly demand estimated from historical data, AQD is used as the measure of essentiality (i.e. E=AQD). This is designed to increase the depth of items with historical demand, since the range cut forces the AQD to be greater than one.

D. COMPUTING LOAD LIST QUANTITIES

Once these variables have been determined, they become inputs to the depth computation, which is the only place where the mathematics of the single period constrained inventory model is used. The assumed model is :

$$\text{minimize} \quad \sum_{i=1}^{n} Ci \times Zi / Ei$$

$$\text{subject to} \quad \frac{\sum_{i=1}^{n} \frac{(Ui - Vi)}{Ai}}{Ui/Ai} \geq .85$$

Ci is the unit cost for item i;

Ei is the essentiality for item i;

Zi is the quantity stocked of item i;

Ui is the average quarterly demand for item i;

Vi is the average quarterly units short for item i;

Ai is the average requisition size for item i.

The solution of this model is by the Lagrange multiplier method. Assuming a normal distribution for demand, the following equations are obtained:

1. $Zi = Ui + Si \times \Phi^{-1}\left(\frac{Ci \cdot Ai}{Ei \cdot \theta}\right) \qquad i=1,2,3,\ldots n$

2. $$.15 \sum_{i=1}^{n} \frac{Ui}{Ai} = \sum_{i=1}^{n} Si\left[\phi\left(\frac{Zi-Ui}{Si}\right) - \left(\frac{Zi-Ui}{Si}\right)\Phi\left(\frac{Zi-Ui}{Si}\right)\right],$$ where

θ is the Lagrange multiplier

Si is the standard deviation for item i;

ϕ is the density of the normal distribution;

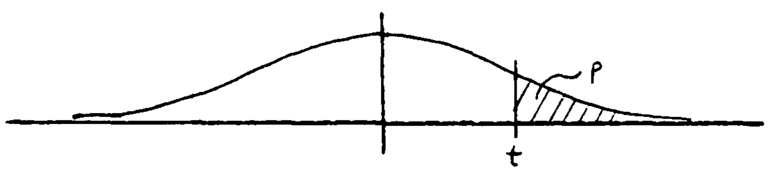
Φ is the cumulative distributiion function of the normal distribution.

Equations 1. and 2. must be solved simultaneously for Zi and θ. The iterative approach is used for solution. The Lagrange multiplier is fixed, the quantities Zi are computed for each item using equation 1, and then equation 2 is solved to determine effectiveness. The Lagrange multiplier is changed and new Zi are computed until constraint equation 2 is satisfied.

The controlling term in the solution of the model is the Lagrange multiplier. In the TARSLL computations, the risk parameter λ is defined as $1/\theta$ and the following is called the risk equation:

$p = \lambda CA/E$ where p is the "risk"

A quick look at the term $\Phi^{-1}\left(\frac{C \cdot A}{E \cdot \theta}\right) = \Phi^{-1}(p)$ will explain why p is referred to as the risk. The risk is the probability that demand will be greater than the value $t = \phi^{-1}(p)$ as determined from a normal distribution.



Since p is a probability, it must be greater than zero but less than one. The solution of the risk equation is the first step in determining the depth of an item. As mentioned earlier, the risk parameter is set for each iteration and the cost, average requisition size and essentiality are known constants for each item. However, there is no guarantee that the solution of the risk equation will result

in a number in this range. Therefore, the value of p is constrained to be between 0 and 1.

After the risk p is determined, the normal distribution is used to determine the number t such that the probability that demand is greater than t is the risk. That is, $t=\Phi^{-1}(p)$. The depth Z is determined from the equation

$$Z = AQD + SIGMA \times t$$

It should be noted that t can be either positive or negative. Thus depending on the risk allowed, t standard deviations of demand can either be added to or subtracted from the average quarterly demand in computing depth. This preliminary depth is then rounded and subjected to several restrictions to give the final load list quantity.

E. QUANTITY CONSTRAINTS

The primary constraint is the minimum quantity (one) specified by the range cut criterion. Other quantity restrictions are minimum, maximum, mandatory, and exclusion overrides applied to specific items. These are used to set upper or lower limits on the quantity to be carried or to specify a mandatory quantity. An exclusion override is a special case of the mandatory override in which the quantity is zero. Quantity overrides are usually identified prior to the running of the model. One of the more common overrides is a maximum quantity override specified by the fleet because of volume constraints. The next restiction is that no less than one dollar's worth of the item will be stocked. i.e. the quantity is increased such that the extended dollar value is greater than $1.00. Another restiction is that the change in the load-list quantity must exceed 25 percent before the load list will be adjusted to the new quantity. This is to eliminate the handling costs associated with small quantity changes. The new load-list quantity must also be in even multiples of the item's minimum replacement unit (MRU). The MRU reflects the minimum number of units

required to perform a task and may vary among APL's. The MRU for any item is the maximum of the MRU's appearing on the applicable APL's. Finally, for items without historical demand, the load list quantity is constrained to be less than 50 units and have an extended value less than $100. This constraint is designed to prevent the stocking of an excessive quantity or dollar value of an item based on an erroneous BRF estimate of demand.

F. EFFECTIVENESS PREDICTION

After the item quantity is determined, preliminary statistics concerning the item are accumulated. These statistics include a tally of the various overrides and restrictions applied, the method of estimating demand, and the extended dollar value of the item. The predicted quarterly demand quantity and frequency and the number of units and requisitions satisfied are also accumulated. These last statistics will be used to predict load list effectiveness after all candidate items have been processed. The number of units satisfied is estimated by assuming a normal distribution of demand to estimate the units short and subtracting this from the estimated average quarterly demand. The following formula is used to predict the units short:

$$\text{Units Short} = S\left[\phi\left(\frac{Z-U}{S}\right) - \left(\frac{Z-U}{S}\right)\Phi\left(\frac{Z-U}{S}\right)\right]$$

The predicted units short is constrained to be greater than zero, but less than or equal to the average quarterly demand, to prevent absurdities from entering the statistics. Similarly, requisitions satisfied is the difference between the quarterly demand frequency and the requisitions short. The requisitions short is computed by dividing the units short by the average requisition size.

After each candidate has been evaluated by the model to determine its load list quantity and the associated

statistics, a final computation of effectiveness is made. Net unit and requisition effectiveness are calculated by dividing the total units and requisitions satisfied by the total demand quantity and frequency, respectively, for load list items. Gross unit and requisition effectiveness are similarly computed except that non-load-list demands are also included. If the net requisition effectiveness meets the 85 percent goal then the optimal load list quantities have been determined. If requisition effectiveness is less than 85 percent then a new risk parameter smaller than the last λ is picked (i.e. less risk), and the model is rerun for all candidate items. If effectiveness is significantly more than 85 percent, then too much money is being spent for the desired effectiveness, and the load is reduced by picking a larger λ (i.e. more risk). Each successive run of the model is analyzed, and the risk parameter is changed until the predicted effectiveness is within tolerance of the desired effectiveness.

IV. ANALYSIS OF THE 1977 AD/AR TARSLL INVENTORY MODEL

A. THE BASIC TARSLL

The first step in analyzing the 1977 TARSLL was to develop the basic load list. A detailed flow chart of the TARSLL computer program obtained from FMSO was used to develop a FORTRAN program of the TARSLL model. In addition to the normal range, dollar value, and effectiveness statistics normally output, the program was modified to provide the distributions of essentiality, average quarterly demand (AQD), average requisition size (ARS), cost, and load list quantity. The input to this program was obtained from SPCC's files and included the parameter values and input tapes of the candidate items used to run the 1977 TARSLL. The results given in Appendix A were obtained from a run of the program. The load list range of 13,217 line items and value of $760,671 are comparable to the final 1977 TARSLL that went to the fleet. Of interest is the fact that no quantity overrides were applied to any items. Also the 85 percent effectiveness criterion was not met (see Figure 1). This presented no problem for this analysis since this TARSLL serves only as a baseline of comparison for other models. Another interesting feature of the output is the observation that the distributions of AQD, ARS, cost, and depth all decayed at an exponential or greater rate. To accomodate this the logarithms of the quantities were used for graphing purposes (see Appendix A). Other aspects of the output statistics will be discussed as they apply to different changes in the model.

Figure 1
1977 TARSLL

Predicted	ER	NER	TOTAL	ACTUAL
Net Unit	84.50	68.84	78.66	78.63
Gross Unit	71.21	58.08	66.32	59.18
Net Reqn	57.82	41.15	42.72	61.61
Gross Reqn	38.77	38.92	38.90	34.04

B. ACTUAL EFFECTIVENESS COMPUTATIONS

To determine the true effectiveness of the 1977 TARSLL, and to evaluate the effects of various changes to the model, 24 months of demand history from the MLSF data file were retrieved. The data was for the period October 1977 to September 1979, and included all of the demand data for the 5 currently active AD's and the only currently active AR in the Atlantic fleet. For the effectiveness computations the 24 months of data were divided into 22 consecutive overlapping quarters, i.e. September, October, November 1977 was the first quarter; October, November, December 1977 was the second quarter; November, December 1977, January 1978 was the third quarter; etc. Each of the six load list ships carried the same load, and no allowance was made for demand-based changes to the load list. The load list was considered to be 100 percent on board at the beginning of each quarter and was not resupplied during the quarter. This was done to simulate the 90 day wartime environment. Net and gross unit effectiveness and net and gross requisition effectiveness were computed for each of the 22 quarters for each tender or repair ship. These were then averaged to give the fleet effectiveness by quarter. Unit effectiveness is the simple average of the number of units satisfied by a tender or repair ship in a three month period divided by the number of units demanded in the same period. For net effectiveness, only demands for items on the TARSLL are included in the computations, whereas for gross effectiveness all demands are counted. In computing requisition effectiveness, each data element is considered a requisition, and a requisition which is only partially filled is considered not filled. Requisition effectiveness is then computed as the ratio of requisitions filled divided by the total requisitions in a three month period.

The first item of interest to be examined in the output of the historical effectiveness computations (see Appendix B) was the relative effectiveness of the load list on the five tenders and one repair ship. No single tender was better or worse across all four measures of effectiveness than the other tenders. The repair ship, however, was worse in all measures than each tender, averaging about ten percent below the mean. Even so, the total variation in effectiveness was small. The standard deviation was less than 3 percent for net effectiveness and less than 5 percent for gross effectiveness. These results held for all effectiveness computations for all variations of the TARSLL model. Therefore only the fleet-wide summary statistics will be used in subsequent comparisons of different models.

The effectiveness results were also examined to see if there was a serious degradation in effectiveness over time. It was obvious that some degradation was occurring over the two-year period, but the amount was less than 5 percent across all measures of effectiveness (see Appendix B). This indicates that the current policy of developing a new TARSLL every 3 years is adequate to provide the desired performance.

The last analysis considered the interrelationships among the four measures of effectiveness, and the relationship between the predictions made by the TARSLL program and the four actual measures of effectiveness. As expected, the net effectiveness measures were significantly higher than the gross effectiveness measures, and unit effectiveness was better than requisition effectiveness. All of the effectiveness measures were within 5 percentage points of the predicted values except net requisition effectiveness (see Figure 1). These results were not too surprising although the actual net unit effectiveness was closer to the predicted value than had been expected, based

on the type commander's comments. The closeness of the predicted and actual effectiveness measures indicates that the composition of the 1977-1979 data is similar to the two years (1975-1976) of data used to develop the TARSLL. The big surprise was the size of the difference between actual and predicted net requisition effectiveness. The difference of almost 20 percentage points indicates that net requisition effectiveness may not be a good goal for the model. This will be investigated further as different models are applied.

C. ESSENTIALITY DETERMINATION

The first change to the model to be investigated concerns the determination of essentiality. As described previously, the 1977 TARSLL used the AQD for essentiality for all items with a demand history and used an essentiality factor between 0 and 1 computed from the Military Essentiality Codes for all other items. The proposed change is to use the predicted AQD as the measure of essentiality for all items. Since the BRF method was not considered as reliable an estimate of future demand as historical data, a larger risk of stockout was allowed for items without historical demand. This was accomplished by using the smaller essentiality factor computed from the MEC's. Because essentiality appears in the denominator of the risk equation, a decrease in its value increases the risk of stockout. An analysis of the MLSF data (see Appendix C) reveals, however, that for the majority of the items, historical demand may be no better an estimate of future demand than the BRF computation. Almost half of the MLSF items appeared only once, and 77 percent appeared 3 times or less. This low demand frequency over a two year period makes the problem of predicting the number of demands in a period very difficult. With the increased confidence in the BRF recently shown by SPCC, the essentiality factor was changed

to the AQD for all candidate items for the 1980 TARSLL. This increased the essentiality for items without historical demand from an average value of .67 (see Appendix A) to over 1.5 (forced by the range cut). The resulting decrease in risk will increase the depth of items with high predicted demand and reduce the number of maximum risk constrained items. The result should be increased net effectiveness. When this change is made to the model, the cost of ER items increases from $375,744 to $435,236, and the distribution of the depth of the load list items shifts upward (see Appendix D). The number of ER items with a maximum risk constraint decreased from 2778 to 1863, but the number of minimum risk constrained items increased from 1237 to 2899, confirming the general risk shift due to the essentiality change. A total of 22,792 units were added. The predicted unit effectiveness showed modest increases of 3 to 5 percent (see Figure 2). Requisition effectiveness, however, showed large gains, with net requisition effectiveness increasing dramatically. Of course the key question is whether the actual effectiveness showed a corresponding increase. Unfortunately this was not the case, as all four of the effectiveness measures increased only slightly. 1Thus the small increase in depth and dollar cost from this change does not significantly improve actual effectiveness. It does, however, bring the requisition effectiveness predictions much closer to the actual figures.

Figure 2

	1977 TARSLL		E = AQD	
	Predicted	Actual	Predicted	Actual
Net Unit	78.66	78.63	83.77	78.69
Gross Unit	66.32	59.17	69.99	59.21
Net Reqn	42.72	61.61	71.78	62.05
Gross Reqn	38.90	34.02	62.31	34.25

D. IMPACT OF THE K3 FACTOR

The next change to be investigated was the change of the K3 factor from .33 to .6. K3 is used in the BRF method of computing AQD to indicate the percent of items installable

at no lower than the tender level that are likely to be installed by a tender or repair ship. The value of .33 was chosen when tenders and repair ships had separate load lists. Since tenders are one of three activities (tenders, repair ships, and shipyards) that can install the part, the likelyhood is .33 that it would install the part. With the introduction to the fleet of larger and more capable tenders, most of the repair ships were decommissioned, and their share of the workload was split between the tenders and shipyards. The reduction in repair ships also brought about a merger of the AD and AR load lists. When this happened, though, the likelihood value of .33 was not changed. The new value of .6 for K3 is designed to represent this merger of the AD and AR TARSLL's and the new split in workload between tenders and shipyards. This change to the model, however, is more of a theoretical purification than an actual substantive change. The change resulted in a small increase in the number of units carried, and a corresponding increase of only $6000 in total load list cost (see Appendix E). The predicted effectiveness dropped slightly across all measures of effectiveness, and actual effectiveness remained about the same (see Figure 3). This is due to the higher demand predicted for most ER items. Again, there was a large disparity of over 20 percentage points between predicted and actual net requisition effectiveness.

Figure 3

	1977 TARSLL		MODEL WITH K3=.6	
	Predicted	Actual	Predicted	Actual
Net Unit	78.66	78.63	77.66	78.63
Gross Unit	66.32	59.17	65.57	59.18
Net Reqn	42.72	61.61	39.83	61.61
Gross Reqn	38.90	34.02	36.56	34.04

E. RANGE DETERMINATION

The range cut had the greatest affect on the TARSLL. Without changing this factor there can be no change in the line items being carried. The Commander, Naval Surface Forces Atlantic Fleet has specified the number of line items

to be about 15,000. This number is derived based on past experience to provide an adequate balance between the range of items carried and the number of items that have no demand. This is also used to meet the volume constraints aboard the tenders and repair ships. The range-cut factor used in the development of the 1977 AD/AR TARSLL was 12. This means that an item had to have predicted demand of 12 units in eight quarters to be carried. This is equivalent to an AQD of 1.5. Less than 7 percent of the ER and 25 percent of the NER items satisfied this very restrictive criterion. The two options of interest are 1) a range cut of 4 (AQD=.5); and 2) no range cut. The range cut of 4 has been suggested for the 1980 TARSLL, and the "no-range-cut" option is used for FBM submarine tenders.

Because a range cut of 4 forces onto the load list any item with an AQD greater than 0.5, the number of line items carried nearly doubled to a total of 25,226 items, with 12,215 of these at a depth of one. The distribution of depth was essentially unchanged above 10 units, with the total number of units increasing only 7 percent (see Appendix F). The total cost of the load list also doubled to over $1.5 million. Interestingly, over 85 percent of the increase in both line items and cost came from ER items, with two-thirds of those using the BRF method of predicting demand (see Appendix D). The results of the effectiveness predictions were interesting because net unit effectiveness decreased while net requisition effectiveness increased (see Figure 4), indicating that the unit effectiveness for the added items was less than for those in the base TARSLL, but that the average requisition sizes were smaller and yielded better requisition effectiveness. As was expected, both gross unit and gross requisition effectiveness increased slightly. Even more interesting were the results of the actual effectiveness computations. The gross effectiveness

measures both increased slightly but the net effectiveness measures both decreased slightly (see Figure 4). Therefore, this range cut does not seem justified.

Figure 4

	1977 TARSLL		RC = 4	
	Predicted	Actual	Predicted	Actual
Net Unit	78.66	78.63	77.65	77.28
Gross Unit	66.32	59.17	68.17	59.69
Net Reqn	42.72	61.61	45.07	38.01
Gross Reqn	38.90	34.02	36.56	34.04

There are two aspects of the no-range-cut option that affect the load list. The first is that items are not required to have a minimum predicted AQD to be considered by the model as candidates for inclusion in the load list. The second, and perhaps more important, fact is that no items are forced on the load list. The results of eliminating the range cut are startling. A total of 19,915 items are carried on this load list. The number of ER items nearly doubled, but the number of NER items dropped by over a third. The depth of the line items carried also showed a significant increase with less than half of the number of items stocked at the level of one. All other depths less than 10 had large increases, but above 10 units there was very little change. This resulted in only a 13 percent increase in the total number of units carried. The greatest change was in the cost of the load list. Despite the large increase in the number of items carried, the dollar value was half that of the base TARSLL (see Appendix G). The predicted effectiveness improved significantly with net requisition effectiveness nearly doubling. Actual effectiveness gains were not so dramatic. Net requisition effectiveness was the only measure which had an increase over 3 percentage points (see Figure 5). That net requisition effectiveness went from a value considerably below actual effectiveness in the base TARSLL to a value slightly above actual in the no-range-cut load list is particularly noteworthy. This again points to the unreliability of predicted net requisition effectiveness as

a measure of actual load list effectiveness. Thus, despite the large number of line items carried, the no-range-cut option deserves further investigation because it produces generally better effectiveness at a much lower cost.

Figure 5

	1977 TARSLL		MODEL WITH RC=0	
	Predicted	Actual	Predicted	Actual
Net Unit	78.66	78.63	90.86	81.37
Gross Unit	66.32	59.17	67.90	59.28
Net Reqn	42.72	61.61	80.69	76.14
Gross Reqn	38.90	34.02	65.55	32.40

A simple modification to the no-range-cut option would be the addition of a constraint that requires an item have an AQD of at least 0.5 in order to be carried. This is essentially equivalent to requiring a range cut of four except that no items would be forced on the load list, since the items with an AQD less than 0.5 would be the only items eliminated from consideration, the results of this modification should be a general reduction in the number of line items carried without a significant reduction in effectiveness. This is in fact what happens (see Appendix H). The number of line items drops to 13,477, just slightly more than the base TARSLL number. The greatest decrease is in the number of items with a depth of one or two from 4505 to 2251 line items. The total number of units also drops to only 5.3 percent above the base TARSLL. The total load-list cost drops only slightly to $366,755, but is still less than half the cost of the base TARSLL. A quick look at the cost distributions for these two load lists explains the difference. The cost of about 72 percent of the items on the 1977 TARSLL was less than five dollars each, but the rest of the items ranged to a maximum of $34,780, including 85 items over $600 each. In contrast, over 97 percent of this modified no-range-cut load list had a cost of less than five dollars and no item cost more than $286. In comparison to the no-range-cut option, the predicted effectiveness drops slightly but actual effectiveness remains about the same In

comparison to the basic TARSLL model with a range cut of 12, this load list has about the same number of line items and total units at less than half the cost, yet with generally better effectiveness (see Figure 6). Therefore this range cut modification appears to be a significant improvement over the current range cut procedure.

Figure 6

	1977 TARSLL		MODIFIED RC=0 MODEL	
	Predicted	Actual	Predicted	Actual
Net Unit	78.66	78.63	90.82	81.76
Gross Unit	66.32	59.17	67.34	59.11
Net Reqn	42.72	61.61	79.62	76.62
Gross Reqn	38.90	34.02	63.68	31.70

F. EFFECTIVENESS CRITERIA

As noted previously, the predicted net requisition effectiveness can fluctuate widely without corresponding fluctuations in the actual net requisition effectiveness. A similar but more stable measure of effectiveness is the net unit effectiveness. This measure did not vary as much throughout the many changes, and its predicted and actual values were fairly close. Net unit effectiveness also has an intuitive appeal. Since tender peacetime industrial work often involves the overhaul of equipment, more units of a line item may be used than would be necessary for the basic repair job that would be accomplished in a wartime environment. Also, the wide variances in the distribution of average requisition size for the MLSF demand data (see Appendix B) indicate that one requisition may not be used for only one job. Although half of the items have an ARS of 5 units or less, over 85 units have an ARS greater than 600 units and one item has an ARS of 25,250 units. Thus unit effectiveness may be a better indicator of load list performance. A change in the performance measure, however, necessitates a change in the mathematical model. In the basic TARSLL model the risk equation is

$$p = \lambda CA/E$$

The "A" or average requisition size appears in the equation

because of the constraint of 85 percent net requisition effectiveness. With the change to the unit effectiveness measure, A disappears. This is the same as setting A=1 for all items, which is done for those items that use the BRF computation to estimate demand. Therefore this change only affects the depth of those items with historical data based demand predictions. Setting A=1 for the depth computation will reduce the risk and correspondingly increase the depth on those items. The result is a large increase in the depth and cost of these items. The number of units carried jumps to 815,202 and the cost increases by $640,000 to over $1.4 million (see Appendix I). Actual and predicted effectiveness increased for all four effectiveness measures. The largest increase was found in actual net requisition effectiveness which increased over 15 percentage points (see Figure 7). Thus a change in the measure of effectiveness to net unit effectiveness results in a significant improvement in all effectiveness measures, but at a correspondingly large increase in cost.

Figure 7

	1977 TARSLL		MODEL WITH A=1	
	Predicted	Actual	Predicted	Actual
Net Unit	78.66	78.63	89.01	84.68
Gross Unit	66.32	59.17	75.01	63.64
Net Reqn	42.72	61.61	46.63	76.11
Gross Reqn	38.90	34.02	42.46	41.93

V. ALTERNATIVE MODELS

A. MODIFIED 1980 TARSLL MODEL

As mentioned previously, several changes have been incorporated into the 1980 TARSLL model. These are the use of AQD as the measure of essentiality, K3 equal to .6, and a range cut of 4. To determine their cumulative effect, these changes were incorporated into the 1977 TARSLL model. The range cut criterion was modified so that items passing the range cut were not forced onto the load list. This was done because, as discussed in chapter 4, the normal range cut procedure would have resulted in a range of over 25,000 line items, far exceeding the 15,000 line item target set by the type commander. This model results in a load list with 15,166 line items at a cost of $444,311 (see Appendix J). This 40 percent cost reduction from the 1977 TARSLL was achieved despite a 10 percent increase in the total units carried by eliminating any item with a unit cost over $286. The cost distribution for this model is nearly identical to the modified no-range-cut model. As expected there are large increases in both predicted and actual effectiveness (see Figure 8). The predicted effectiveness results were better

Figure 8

	1977 TARSLL		1980 TARSLL	
	Predicted	Actual	Predicted	Actual
Net Unit	78.66	78.63	91.76	81.73
Gross Unit	66.32	59.17	71.18	59.17
Net Reqn	42.72	61.61	88.40	76.70
Gross Reqn	38.90	34.02	70.87	32.07

than the results obtained when each of the three changes was implemented separately. The results of the actual effectiveness computations were similar to the modified no-range-cut results. This is not surprising since the only one of the three changes that had a significant impact on actual effectiveness was the range cut change. In light of

the improved net effectiveness and the significantly lower cost of this model, the changes appear warranted.

B. FBM SUBMARINE TENDER MODEL

Tenders supporting FBM submarines (AS-FBM) use a model that is slightly different from the 1977 TARSLL model. Two differences that have already been discussed are the use of AQD for determining essentiality, and the use of no range cut. A third difference is the use of the Poisson distribution to represent demand for items with a low AQD. The Poisson distribution is commonly used in inventory models to represent independent demands occurring at a constant rate. In inventory situations at SPCC, the Poisson distribution is only used up to a demand of 10 units because of the computational problems resulting from the iterative process used to determine the probability of demand. Above 10 units the normal distribution is used with the central limit theorem offered as justification. The no-range-cut procedure was modified to allow for consideration only of items with AQD greater than 0.5. This is the same modification that produced significant improvement in the 1977 TARSLL. It also results in the same range-cut criterion that was used in the 1980 TARSLL model examined above. This makes analysis of the effects of the Poisson distribution easier, since now the only difference between the AS-FBM model and the 1980 TARSLL model discussed above is the use of the Poisson distribution. The use of the Poisson distribution produced unusual results (see Appendix K). Compared to the 1980 TARSLL, the AS-FBM model had a significant increase in the number of line items to 16,225. The total number of units, however, decreased slightly to 685,010. This was due predominantly to a substantial reduction in the number of items with a depth of between 20 and 40 units, and an increase in the number of items with a

depth of up to five units. Despite the decrease in total units, the load list cost increased by 25 percent. This resulted from carrying many more high priced items, including one that cost $34,780. The effectiveness predictions improved slightly in all areas except net unit effectiveness, which remained essentially the same (see Figure 9). Actual effectiveness, however, had the reverse trend. Gross requisition effectiveness , which had the largest predicted increase of nearly 5 percentage points, was the only measure to show an increase in actual effectiveness. The greatest decline was the over 5 percentage point drop experienced by net requisition effectiveness, which indicates that the predictions obtained using the Poisson distribution are misleading and do not represent the demand as well as the normal distribution. Thus, despite higher cost, this model does not perform as well as the modified 1980 TARSLL.

Figure 9

	AS-FBM MODEL		1980 TARSLL	
	Predicted	Actual	Predicted	Actual
Net Unit	91.75	80.04	91.76	81.73
Gross Unit	73.08	58.96	71.18	59.17
Net Reqn	90.02	69.03	88.40	76.70
Gross Reqn	75.59	32.79	70.87	32.07

C. GAMMA DISTRIBUTION MODEL

An alternative distribution that has greater flexibility in fitting empirical distribution curves is the gamma distribution. Using this distribution in the 1980 TARSLL model has a major impact on the size, cost, and effectiveness of the load list (see Appendix L). The number of line items carried is reduced to 13,704 and the total number of items carried is reduced to 616.616. Correspondingly, the dollar value of the load list is reduced to $330,514. Unfortunately, the predicted and actual effectiveness measures are also significantly lower than the 1980 TARSLL effectiveness values (see Figure 10). Thus the gamma distribution does not appear to provide significantly

better results than the normal distribution. The gamma distribution is also more difficult to implement, increasing the computer time required to generate the load list by nearly 50 percent.

Figure 10

	MODEL WITH GAMMA DIST		1980 TARSLL	
	Predicted	Actual	Predicted	Actual
Net Unit	81.31	77.13	91.76	81.73
Gross Unit	63.56	56.17	71.18	59.17
Net Reqn	78.10	68.13	88.40	76.70
Gross Reqn	63.05	29.09	70.87	32.07

One reason why neither the Poisson nor the gamma distribution improves the load-list effectiveness may be that the distribution is being fit to the wrong data. The constraint on the basic TARSLL model is net requisition effectiveness of 85 percent. However, the distributions are being applied to the unit demand. The ARS factor is then applied to convert the unit demand data to requisition demand data. The proper procedure would be to fit the distribution to the actual demand frequency data. An alternative to this is to use a model that has unit effectivenes as its objective.

D. UNITS SATISFIED MODEL

A completely different approach to the model is to maximize the unit demand satisfied, subject to a budget constraint. Since there is no formal budget constraint on the AD/AR TARSLL, the value (K) of the modified 1980 TARSLL is chosen for comparison purposes. This model can be expressed mathematically as:

$$\text{Maximize} \quad \sum_{i=1}^{n} Ui - Vi$$

$$\text{Subject to} \quad \sum_{i=1}^{n} Ci\ Zi \leq K$$

As with the basic TARSLL model, this problem is solved using a Lagrange multiplier approach. Assuming a normal distribution for demand, the following equations are obtained:

$$1.\ Zi = Ui + \Phi^{-1}(\theta \cdot Ci)\,Si$$

$$2.\ \sum_{i=1}^{n} Ci \cdot Zi \leq K$$

Equations 1. and 2. must be solved simultaneously for Zi and θ. This leads to the same iterative solution procedure used for the basic TARSLL. The only difference is that now the risk equation is $p=\lambda C$ where $\lambda=\theta$. The "A" term has dropped out of the TARSLL risk equation because units, not requisitions, satisfied is being maximized. Similarly, the "E" term has been deleted because there is no essentiality weighting, i.e. one unit demand satisfied is as good as another. If unit effectiveness were maximized, the only difference would be a constant term representing the total demand. The same results could have been obtained by starting with the objective function to minimize total load list cost, subject to the constraint that net unit effectiveness be greater than 85 percent. For comparison purposes, this model was implemented by changing the risk equation in the 1980 TARSLL model above to $p=\lambda \cdot C$ and rerunning the program. For want of anything better, the value of the risk parameter was not changed even though the two parameters do not have the same interpretation. As expected, the results were not optimal. The cost of this load list was less than two-thirds the cost of the modified 1980 TARSLL (see Appendix M). Even so, predicted and actual effectiveness were not much worse than the 1980 TARSLL (see Figure 11). Each of the actual unit effectiveness measures was only about one percentage point lower. The seven percentage point shortfall in each of the requisition effectiveness measures caused a little more concern, but the outlook for significant gains was encouraging. There was one major drawback, however: the load list range of 16,382 items was already considerably above the 15,000 goal set for the TARSLL, and the total units of 711,678 was only slightly

less than the number on the 1980 TARSLL. Therefore, despite its significantly lower cost, this alternative did not satisfy the type commander's criteria as well as the modified 1980 TARSLL model.

Figure 11

	UNITS SAT MODEL		1980 TARSLL	
	Predicted	Actual	Predicted	Actual
Net Unit	90.12	80.52	91.76	81.73
Gross Unit	68.05	58.47	71.18	59.17
Net Regn	79.85	69.58	88.40	76.70
Gross Regn	63.54	25.97	70.87	32.07

E. UNIT EFFECTIVENESS MODEL

The last alternative to be explored was the application of the net unit effectiveness measure to the modified 1980 TARSLL model. As described in chapter 4, the use of the unit effectiveness measure requires setting A=1 in the risk equation. When this is done, and the program rerun, impressive increases compared to the base 1980 TARSLL are obtained in both predicted and actual effectiveness (see Figure 12). It should be noted that these actual effectiveness results are similar to those obtained when this change is made to the 1977 TARSLL model. These effectiveness improvements are accompanied by a significant increase in the size and dollar value of the load list (see Appendix N). At 17,792 line items and 885,655 total units, this alternative load list is much larger than either the 1977 unit effectiveness load list or the basic 1980 TARSLL. The cost of $1.1 million is over 20 percent less than the cost of the comparable 1977 model, but is still over twice the cost of the 1980 TARSLL.

Figure 12

	Unit Effectiveness		1980 TARSLL	
	Predicted	Actual	Predicted	Actual
Net Unit	96.95	84.46	91.76	81.73
Gross Unit	80.53	63.90	71.18	59.17
Net Regn	90.13	81.43	88.40	76.70
Gross Regn	76.51	41.44	70.87	32.07

An interesting question is whether the large increases in the number of items and the dollar value are required to obtain the additional effectiveness. To answer this question

the unit effectiveness modification to the 1980 TARSLL was rerun with a larger risk parameter. The result was a significant reduction in the number of line items to only 9271, but the total number of units decrease only slightly to 764,941 (see Appendix O). This was caused by the elimination of a large number of items with a depth of one or two. Although the load-list cost is reduced by over 50 percent to $465,605, it is still slightly more than the cost of the 1980 TARSLL. Actual effectiveness decreases, however, were minimal (see Figure 13). Thus this model provides significantly better net effectiveness than the 1980 TARSLL model at only a slight increase in cost.

Figure 13

	Unit Effectiveness		1980 TARSLL	
	Predicted	Actual	Predicted	Actual
Net Unit	94.54	84.06	91.76	81.73
Gross Unit	70.83	60.18	71.18	59.17
Net Reqn	80.73	77.98	88.40	76.70
Gross Reqn	57.55	25.54	70.87	32.07

VI. CONCLUSIONS AND RECOMMENDATIONS

The foregoing analysis of the 1977 AD/AR TARSLL examined the mathematics of the load list model and investigated proposed changes to the model. The conclusions to be drawn from this analysis can only be made with respect to the 1977 AD/AR TARSLL. Recommendations to implement certain of these changes on the 1980 and subsequent AD/AR TARSLL's are based on the conclusion that the demand data base is reasonably stable. This was evident from the minimal degradation of effectiveness over the two years of demand data and the closeness of predicted and actual effectiveness computations. This stability also justifies the creation of a new load list every three years.

The change to the use of the AQD as the measure of essentiality for all items has a marginal impact on the 1977 AD/AR TARSLL. There was a modest increase in the size and dollar value of the load list. This was accompanied by an increase of less than one percentage point in each of the four actual effectiveness measures. The increase in the K3 factor from .33 to .6 has minimal impact on the load-list size, cost and effectiveness. Although the change is merely a theoretical purification of the TARSLL process it is justified. The current range-cut process is too restrictive and reduces the effectiveness of the mathematical inventory model. The proposed range cut of four demands in two years produces a load list that is twice as large and expensive as the 1977 TARSLL. However, even with these increases, net effectiveness decreases. Elimination of the range cut provides significant improvements in cost and effectiveness, but the range of the load list is too large. Adding the criterion that predicted demand must exceed four demands in two years for an item to be considered by the model reduces

the load list to the desired size, without significantly affecting effectiveness. The implementation of the essentiality, K3 factor, and range cut changes into the 1977 AD/AR TARSLL resulted in dramatic improvements. The net effectiveness measures improved significantly, while the cost was reduced by 40 percent. Therefore, these changes should be implemented in the 1980 AD/AR TARSLL.

The use of different distributions to represent demand did not result in any major improvements over the use of the normal distribution. The use of the Poisson distribution produced a larger and more costly load list with lower actual effectiveness. The gamma distribution produced a load list with lower cost, but also with correspondingly lower effectiveness. Without major improvements in either cost or effectiveness, the ease of application of the normal distribution makes its use preferable. Therefore, the continued use of the normal distribution is recommended for the 1980 AD/AR TARSLL.

The two basic changes to the model itself were both promising. The units-satisfied model had a lower cost than the 1980 TARSLL model, but its effectiveness was not as good, and the number of line items already exceeded the goal of the type commander. The total number of units, however, was less than the total units on the 1980 TARSLL model. The unit effectiveness model had exactly the reverse situation. It had a low number of units, but a high total unit count. Consequently, it had a higher cost than the 1980 TARSLL. It also had better actual effectiveness. The unit effectiveness model is preferable because of the fewer number of line items. It should be considered as a replacement for the current AD/AR TARSLL model.

APPENDIX A

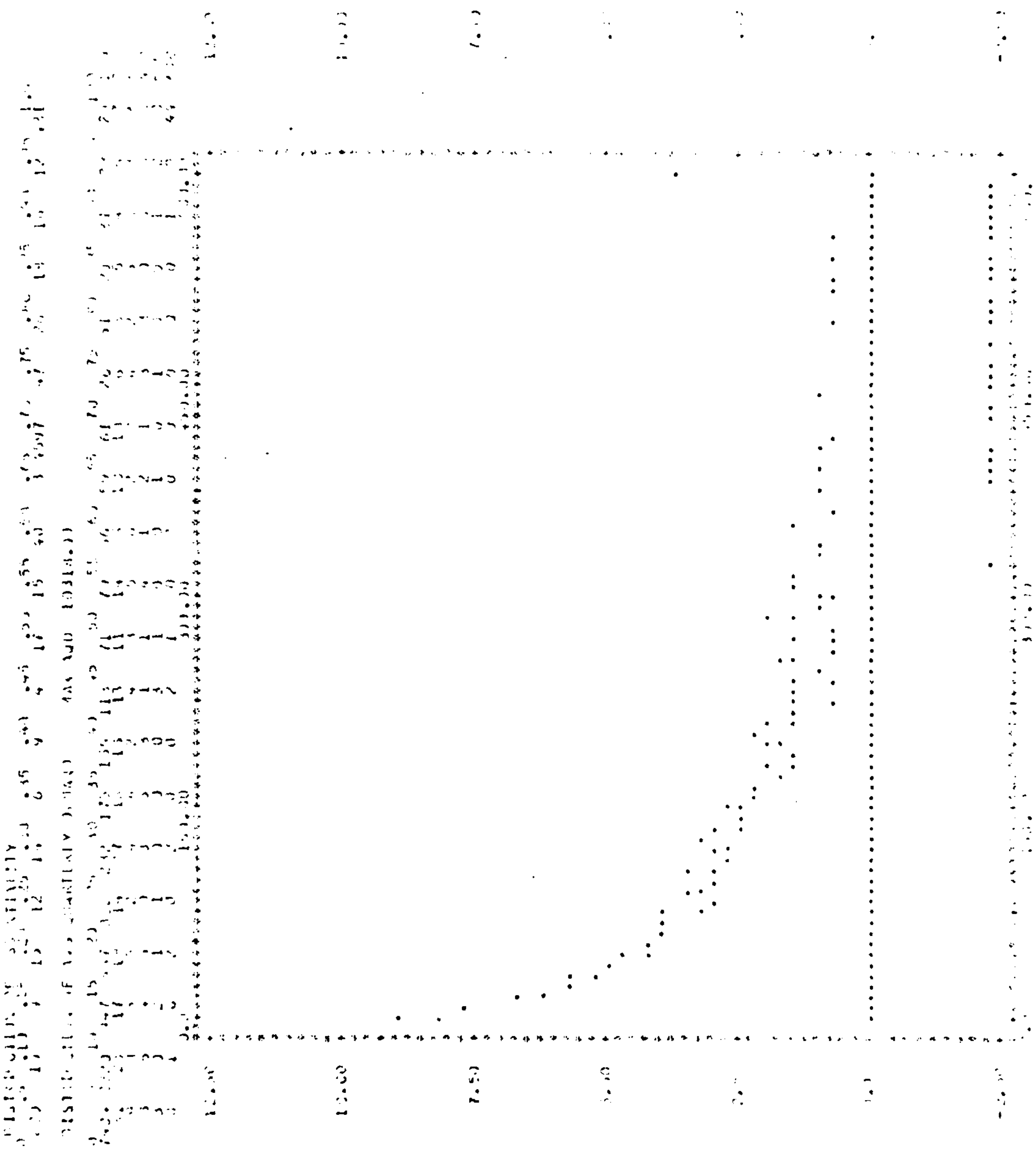
1977 AD/AR TARSLL STATISTICS

TABLE [illegible] LIST OUTPUT STATISTICS

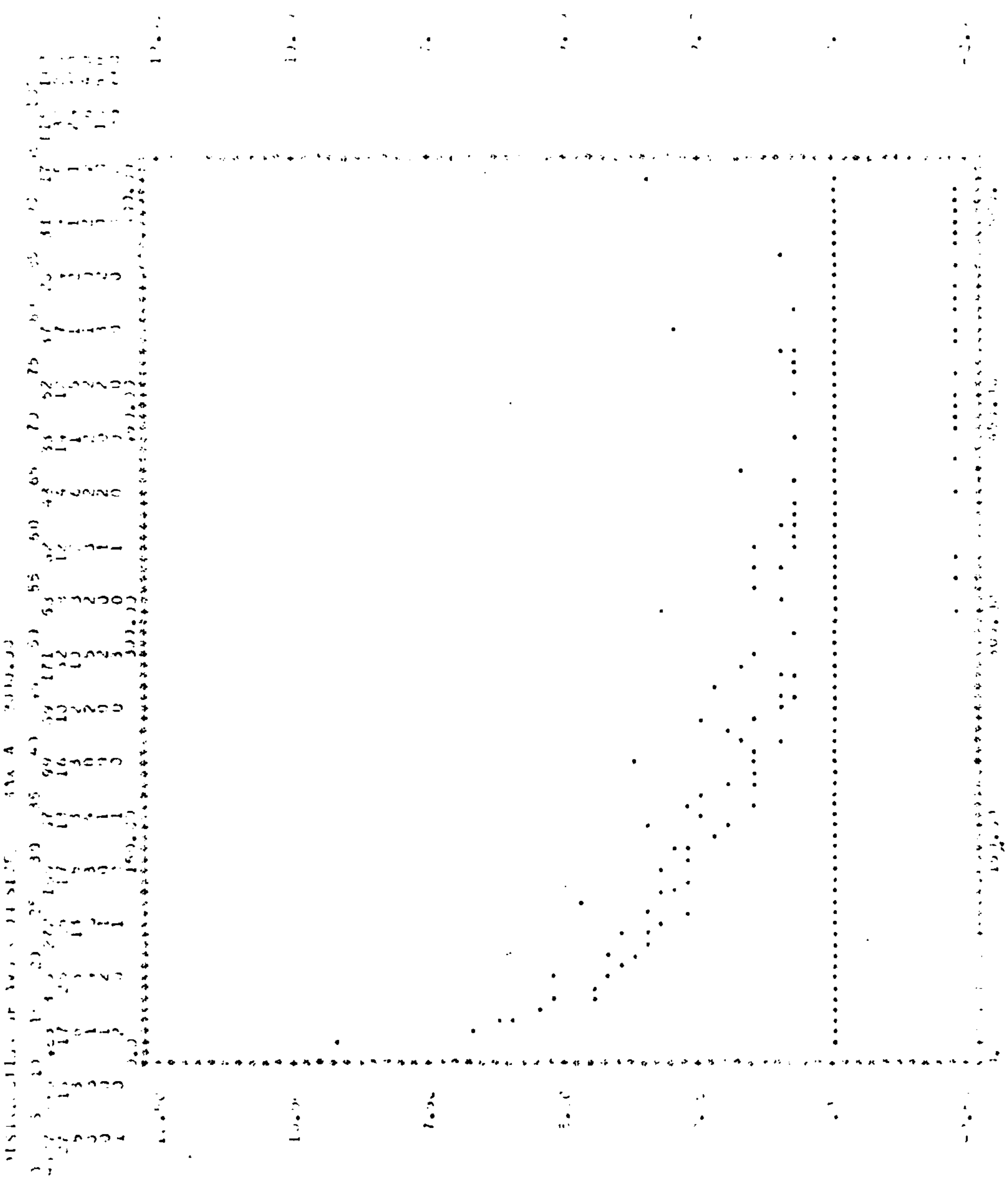
LT = [illegible] LT = [illegible] T = 1.[illegible] RIB = 1.

				TOTAL
CANDIDATES		[illegible]	[illegible]	[illegible]
LL RANGE		[illegible]	[illegible]	[illegible]
LL VALUE		[illegible]	[illegible]	[illegible]
ADDS TO LL		[illegible]	[illegible]	[illegible]
ADDS VALUE		[illegible]	[illegible]	[illegible]
DELETES FM LL		[illegible]	[illegible]	[illegible]
DELETES VALUE		[illegible]	[illegible]	[illegible]
FORCED ON LL		[illegible]	[illegible]	[illegible]
CONSTRAINED QTY		[illegible]	[illegible]	[illegible]
EFFECTIVENESS DATA				
UNITS SAT		[illegible]	[illegible]	[illegible]
REDN SAT		[illegible]	[illegible]	[illegible]
UFD	LL	[illegible]	[illegible]	[illegible]
	NLL	[illegible]	17,11.	[illegible]
	ALL			[illegible]
REQ	LL	[illegible]	[illegible]	[illegible]
	NLL	[illegible]	[illegible]	[illegible]
	ALL			[illegible]
NET UNIT EFF		[illegible]	[illegible]	[illegible]
GROSS UNIT EFF		[illegible]	[illegible]	[illegible]
NET REDN EFF		[illegible]	[illegible]	[illegible]
GROSS REDN EFF		[illegible]	[illegible]	[illegible]
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	[illegible]	[illegible]	[illegible]
	NLL	[illegible]	[illegible]	[illegible]
	ALL			[illegible]
[illegible]	LL	[illegible]	[illegible]	[illegible]
	NLL	[illegible]	[illegible]	[illegible]
	ALL			[illegible]
FORCED [illegible]	LL	[illegible]	[illegible]	[illegible]
	NLL	[illegible]	[illegible]	[illegible]
	ALL			[illegible]
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	[illegible]	[illegible]	[illegible]
	NLL	[illegible]	[illegible]	[illegible]
	ALL			[illegible]
MIN RISK	LL	[illegible]	1237	[illegible]
	NLL	[illegible]	[illegible]	[illegible]
	ALL			[illegible]
OVERRIDES APPLIED				
MANDATORY		[illegible]	[illegible]	[illegible]
MAX QTY		[illegible]	[illegible]	[illegible]
MIN QTY		[illegible]	[illegible]	[illegible]
DELETE		[illegible]	[illegible]	[illegible]

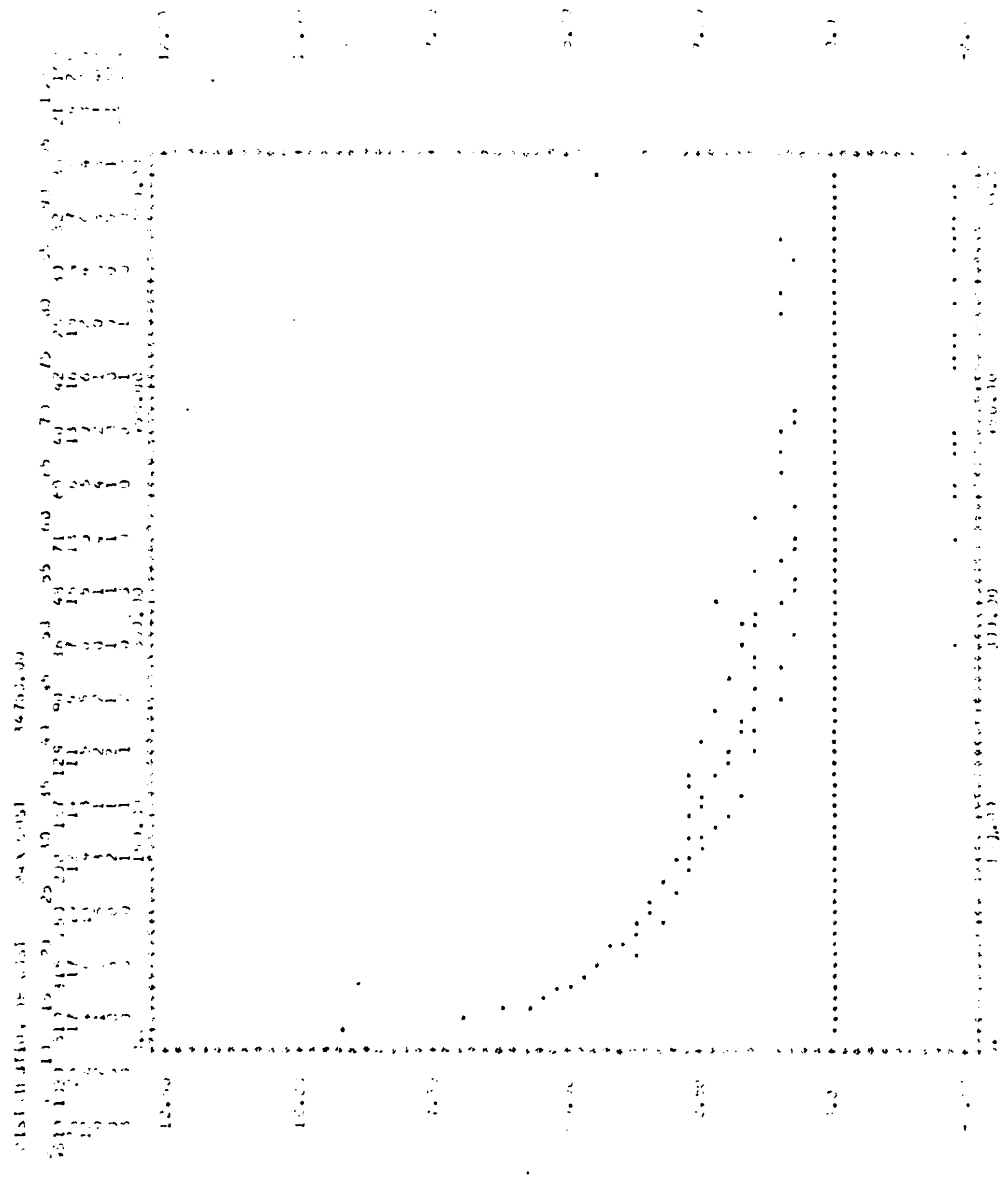
1977 AD/AR TARSLL STATISTICS



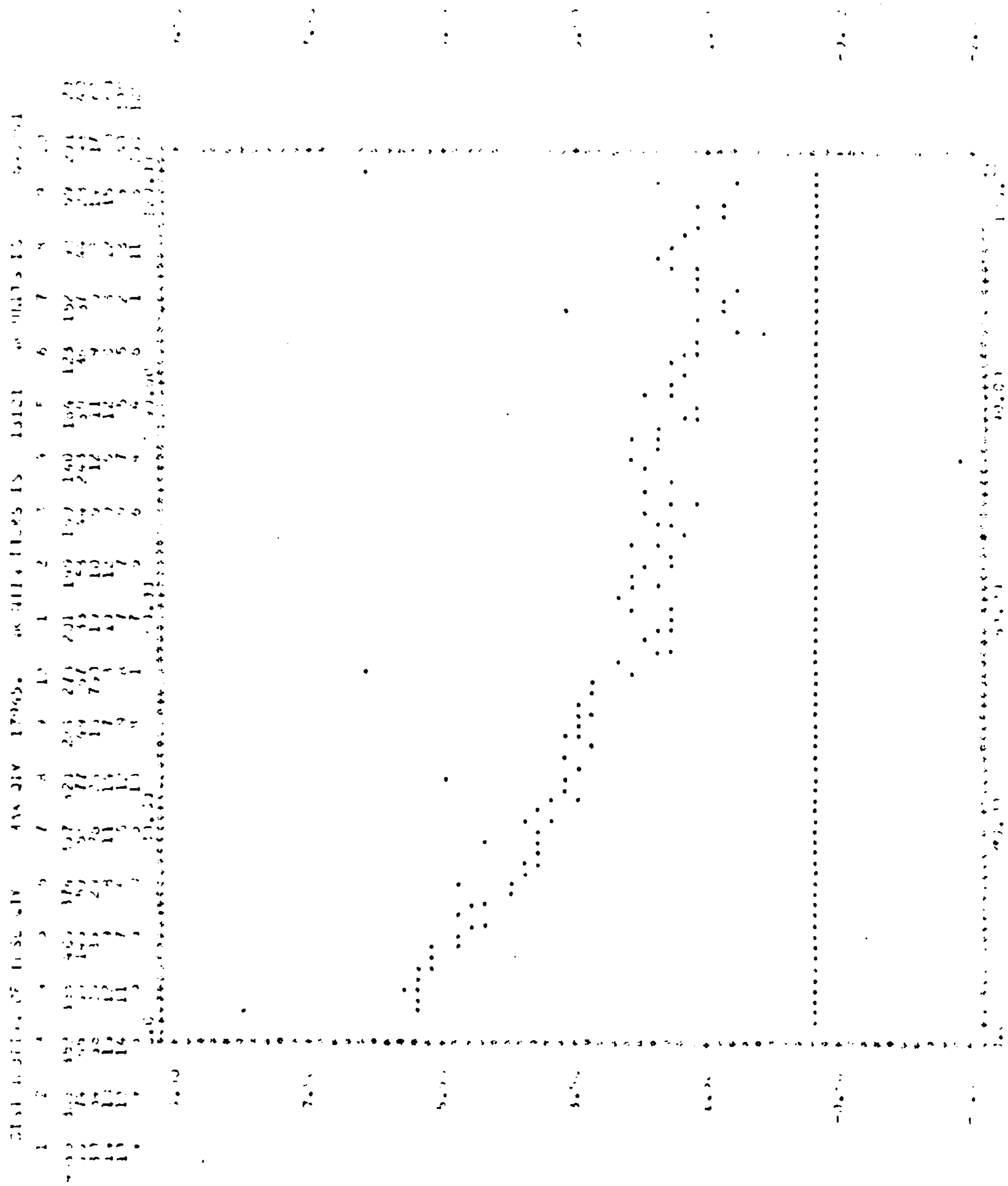
1977 AD/AR TARSLL STATISTICS



1977 AD/AR TARSLL STATISTICS



1977 AD/AR TARSLL STATISTICS



APPENDIX B

1977 AD/AR TARSLL EFFECTIVENESS

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.8309	0.5964	0.6634	0.3783
2	0.8072	0.6056	0.6356	0.3600
3	0.8195	0.6217	0.6390	0.3753
4	0.8060	0.6279	0.6402	0.3947
5	0.8257	0.5577	0.6368	0.4038
6	0.8009	0.6286	0.6119	0.3933
7	0.7950	0.5264	0.6177	0.3385
8	0.8077	0.6538	0.6501	0.4076
9	0.7952	0.6517	0.5605	0.3958
10	0.7599	0.5773	0.6364	0.3646
11	0.7556	0.5378	0.6214	0.3419
12	0.7554	0.5400	0.6218	0.3392
13	0.7780	0.6096	0.6293	0.3340
14	0.7595	0.5679	0.6031	0.3111
15	0.7762	0.5208	0.5870	0.2879
16	0.7852	0.5258	0.5532	0.2621
17	0.7574	0.5141	0.5842	0.2775
18	0.7758	0.5776	0.5896	0.2793
19	0.8042	0.6025	0.5964	0.2893
20	0.7995	0.6057	0.6084	0.2976
21	0.7601	0.5855	0.5853	0.2996
22	0.7457	0.5856	0.5515	0.2335
MEAN	0.7803	0.5917	0.6161	0.3402
S.DEV	0.0235	0.0454	0.0283	0.0474

1977 AD/AR TARSLL EFFECTIVENESS

LOAD LIST EFFECTIVENESS AD 17

QTR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.9415	0.6974	0.7731	0.3868
2	0.9065	0.7444	0.7306	0.3770
3	0.7600	0.6004	0.7293	0.4235
4	0.7555	0.6152	0.6973	0.4315
5	0.7151	0.5560	0.7044	0.4415
6	0.7253	0.5276	0.6353	0.3300
7	0.7444	0.5373	0.7059	0.4280
8	0.7124	0.6185	0.7355	0.4613
9	0.7723	0.5963	0.7750	0.4600
10	0.7953	0.6013	0.7543	0.4291
11	0.8350	0.5400	0.7412	0.4206
12	0.8194	0.6393	0.7204	0.4239
13	0.8195	0.5652	0.7136	0.4073
14	0.7900	0.4984	0.6931	0.3671
15	0.7680	0.2122	0.6248	0.2913
16	0.7501	0.2959	0.6226	0.2867
17	0.7956	0.3253	0.5966	0.2578
18	0.8232	0.5836	0.6311	0.2743
19	0.7949	0.5532	0.5930	0.2674
20	0.7434	0.5523	0.5916	0.2335
21	0.7165	0.5167	0.5735	0.2633
22	0.6976	0.5293	0.5687	0.2763
MEAN	0.7840	0.5543	0.6781	0.3666
S.DEV	0.0605	0.1297	0.0674	0.0751

1977 AD/AR TARSLL EFFECTIVENESS

LOAD LIST EFFECTIVENESS AD 13

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.7557	0.6102	0.6017	0.3447
2	0.7820	0.5744	0.5903	0.3276
3	0.7647	0.5182	0.5965	0.3399
4	0.7963	0.5737	0.5998	0.3610
5	0.8142	0.5531	0.6196	0.3768
6	0.8196	0.5535	0.6157	0.3577
7	0.8719	0.5175	0.6394	0.3423
8	0.9051	0.5354	0.6443	0.3585
9	0.8164	0.5706	0.6055	0.3714
10	0.7464	0.5950	0.5645	0.3460
11	0.7510	0.5707	0.5566	0.3264
12	0.7953	0.5637	0.5987	0.3218
13	0.9097	0.7521	0.7006	0.3751
14	0.8063	0.6219	0.6482	0.3530
15	0.8019	0.6249	0.6221	0.3214
16	0.7864	0.5540	0.5991	0.3023
17	0.8265	0.6265	0.6106	0.2853
18	0.8255	0.6625	0.5954	0.2674
19	0.8214	0.5514	0.6458	0.3059
20	0.8263	0.5511	0.6466	0.3055
21	0.7764	0.6037	0.5852	0.3051
22	0.7124	0.6145	0.4643	0.2497
MEAN	0.8049	0.5965	0.6066	0.3307
S.DEV	0.0487	0.0506	0.0450	0.0333

1977 AD/AR TARSLL EFFECTIVENESS

LOAD LIST EFFECTIVENESS AD 19

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.7724	0.5655	0.6511	0.3446
2	0.7870	0.5825	0.5989	0.3065
3	0.8115	0.6224	0.5962	0.3092
4	0.8212	0.6553	0.5815	0.3108
5	0.8343	0.7807	0.5962	0.3357
6	0.8294	0.7241	0.6217	0.3719
7	0.7137	0.6264	0.5836	0.3536
8	0.8045	0.5900	0.6030	0.3735
9	0.8120	0.6905	0.5695	0.3396
10	0.6517	0.6517	0.5824	0.3263
11	0.7584	0.5444	0.5802	0.3204
12	0.7042	0.5434	0.5535	0.3420
13	0.6905	0.5175	0.5593	0.3121
14	0.7520	0.5083	0.5339	0.2763
15	0.7736	0.5385	0.5293	0.2709
16	0.7067	0.5518	0.5290	0.2674
17	0.7255	0.5730	0.5553	0.2710
18	0.7633	0.5155	0.5572	0.2695
19	0.8013	0.6429	0.5633	0.2690
20	0.8218	0.6411	0.5797	0.2542
21	0.8273	0.5170	0.5717	0.2632
22	0.6725	0.5506	0.5226	0.2479
MEAN	0.7705	0.6138	0.5751	0.3077
S.DEV	0.0666	0.0675	0.0325	0.0392

1977 AD/AR TARSLL EFFECTIVENESS

LOAD LIST EFFECTIVENESS N = 26

QTR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.8915	0.7210	0.7053	0.4770
2	0.8453	0.6392	0.6330	0.4346
3	0.8304	0.6272	0.6953	0.4155
4	0.8017	0.5924	0.6602	0.4322
5	0.8072	0.7148	0.6868	0.4364
6	0.8335	0.7280	0.6763	0.5222
7	0.8395	0.7527	0.7099	0.5349
8	0.8323	0.7617	0.7251	0.5170
9	0.7993	0.7126	0.7022	0.4444
10	0.8144	0.7303	0.6944	0.4531
11	0.7826	0.6031	0.6483	0.3799
12	0.7610	0.5365	0.6396	0.3654
13	0.7581	0.5206	0.6287	0.3337
14	0.7967	0.5503	0.6306	0.3536
15	0.8122	0.5105	0.6299	0.3462
16	0.7971	0.6052	0.6111	0.3263
17	0.7780	0.5658	0.6304	0.3159
18	0.7927	0.5969	0.6476	0.3253
19	0.8605	0.6994	0.6432	0.3518
20	0.8009	0.6963	0.6488	0.3849
21	0.8573	0.6805	0.6537	0.3922
22	0.8137	0.6430	0.6347	0.3799
MEAN	0.8219	0.6493	0.6633	0.4074
S.DEV	0.0335	0.0752	0.0322	0.0582

1977 AD/AR TARSLL EFFECTIVENESS

LOAD LIST EFFECTIVENESS AD 33

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.7039	0.5443	0.6360	0.3766
2	0.7593	0.5299	0.5933	0.3534
3	0.3934	0.7625	0.5694	0.3630
4	0.3202	0.5930	0.6499	0.4134
5	0.3969	0.7472	0.5145	0.4014
6	0.3393	0.5892	0.5227	0.3659
7	0.3675	0.7069	0.4872	0.3278
8	0.3272	0.6612	0.5440	0.3471
9	0.3750	0.7045	0.5753	0.4092
10	0.3025	0.6315	0.6572	0.3271
11	0.3293	0.6551	0.6553	0.3169
12	0.3531	0.6561	0.6276	0.2836
13	0.3505	0.6757	0.5393	0.3064
14	0.3023	0.5243	0.6145	0.2658
15	0.3293	0.6014	0.6128	0.2765
16	0.3509	0.6305	0.6236	0.2677
17	0.3419	0.6372	0.5327	0.3209
18	0.3534	0.6580	0.5281	0.2932
19	0.3504	0.6520	0.6396	0.3096
20	0.3511	0.6325	0.6553	0.2940
21	0.3407	0.5709	0.6127	0.3025
22	0.3467	0.5675	0.5585	0.2314
MEAN	0.3359	0.6556	0.6137	0.3290
S.DEV	0.0451	0.0543	0.0457	0.0446

1977 AD/AR TARSLL EFFECTIVENESS

LOAD LIST EFFECTIVENESS A[illegible] 5

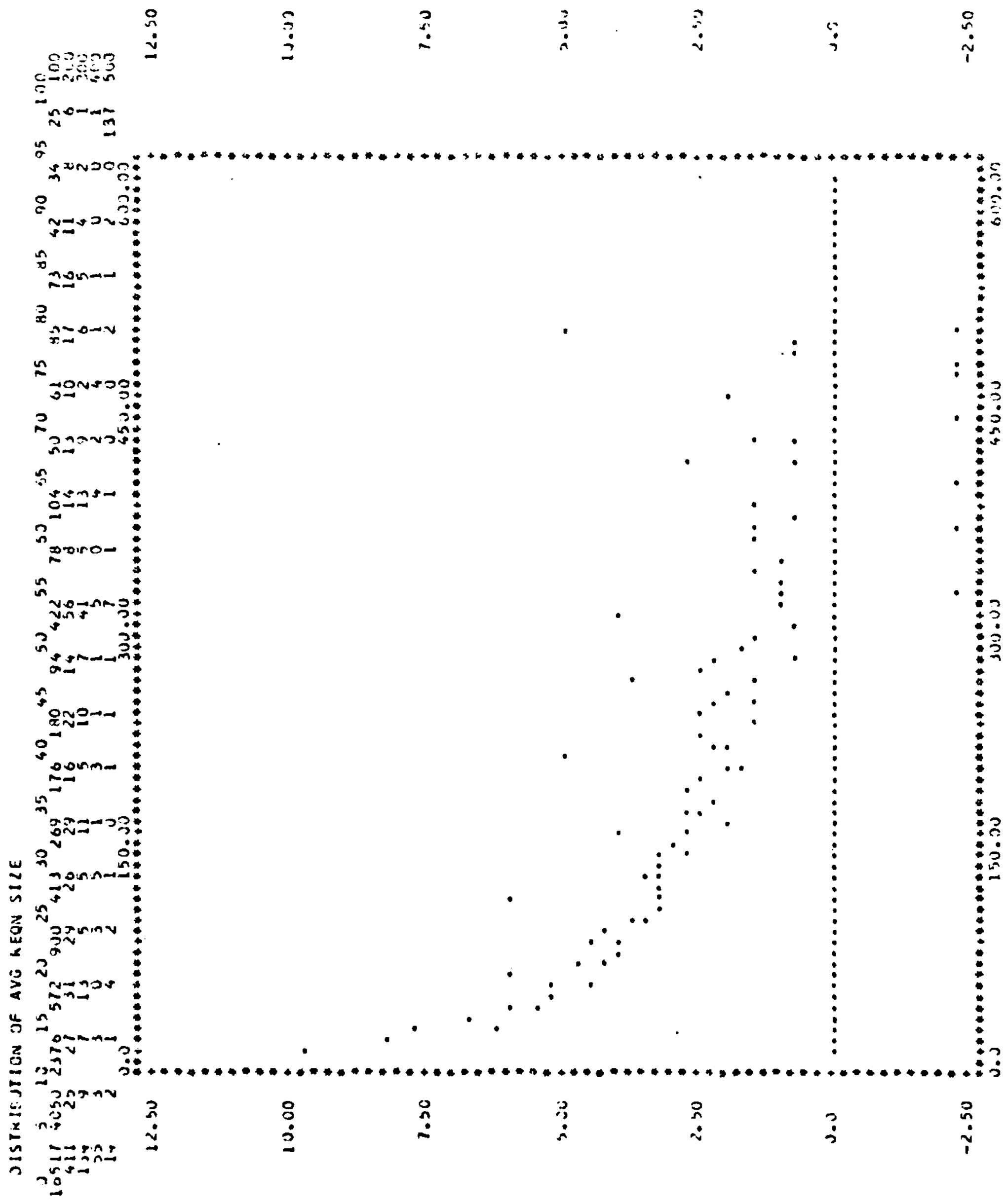
STR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.7455	0.4396	0.6131	0.3341
2	0.7323	0.4043	0.5176	0.3499
3	0.8205	0.5995	0.6331	0.3955
4	0.8405	0.6389	0.6526	0.4193
5	0.7793	0.5835	0.5991	0.3672
6	0.7550	0.5492	0.5966	0.3373
7	0.7232	0.5351	0.5802	0.3447
8	0.7514	0.5740	0.5437	0.3534
9	[illegible]	0.5552	0.6355	0.3503
10	0.8001	0.2525	0.5652	0.3063
11	[illegible]	0.2154	0.5456	0.2353
12	[illegible]	[illegible]	0.5440	[illegible]
13	0.7599	0.3273	0.5373	0.2595
14	[illegible]	0.5155	0.4981	0.2435
15	0.8717	[illegible]	[illegible]	0.2212
16	0.8562	[illegible]	[illegible]	[illegible]
17	[illegible]	0.5553	[illegible]	[illegible]
18	[illegible]	0.3991	[illegible]	0.2213
19	0.8251	0.4757	0.4835	0.2527
20	0.8755	[illegible]	[illegible]	0.2538
21	0.7479	0.6251	0.5133	0.2512
22	0.7554	0.5004	[illegible]	0.2677
MEAN	[illegible]	0.4520	0.5396	0.2993
S.DEV	0.0311	0.1257	0.0559	0.0631

APPENDIX C

MLSF DATA ANALYSIS

[illegible]

MLSF DATA ANALYSIS



<u>APPENDIX D</u>

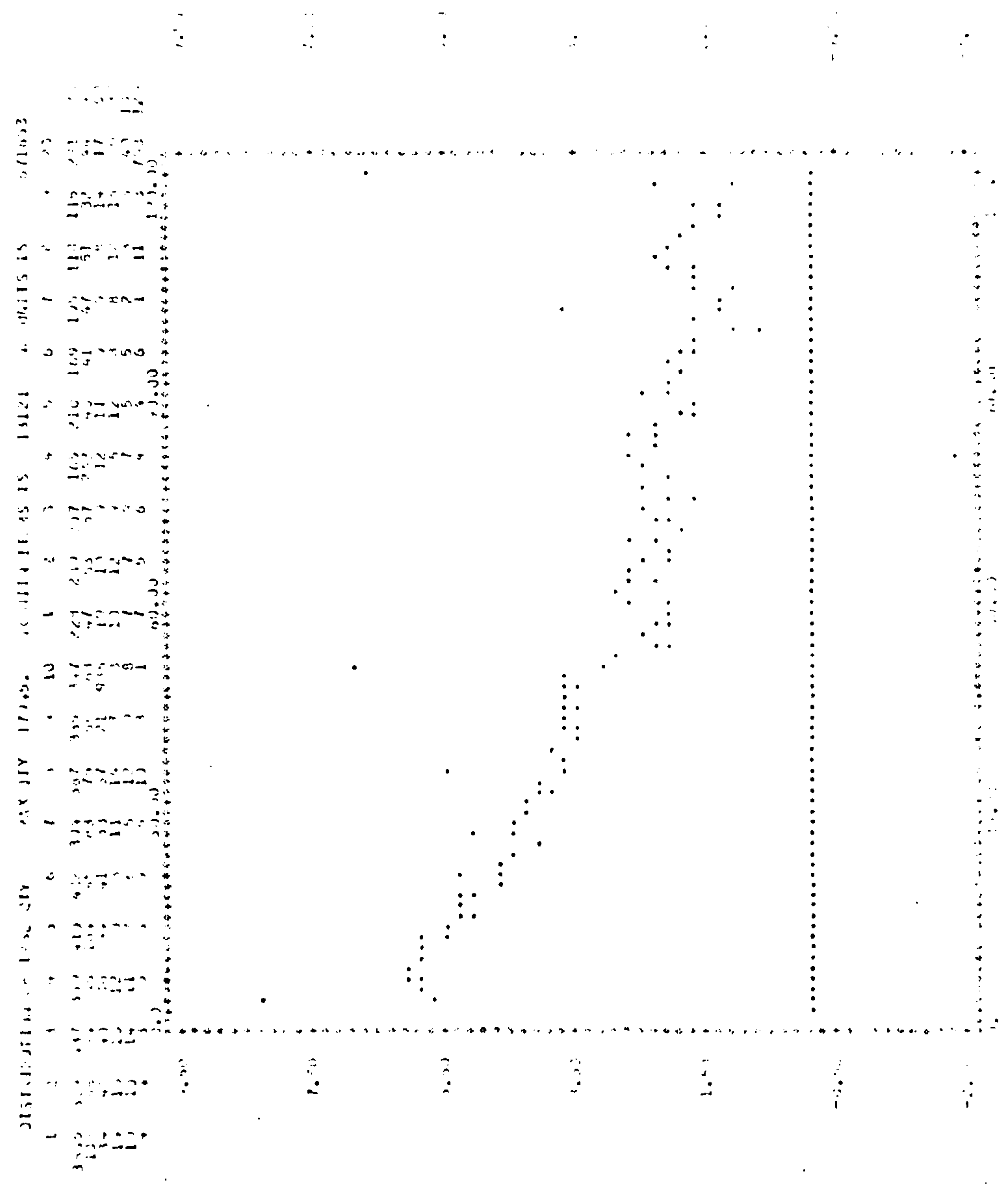
STATISTICS FOR MODEL WITH E=AQD

TABLE LOAD LIST OUTPUT STATISTICS

LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NEP	ER	TOTAL
CANDIDATES		14557	139691	154253
LL RANGE		3557	9660	13217
LL VALUE		384927.	435236.	820163.
ADDS TO LL		3557	9660	13217
ADDS VALUE		384927.	435236.	820163.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		1540	2127	3667
CONSTRAINED QTY		0	1145	1145
EFFECTIVENESS DATA				
UNITS SAT		130451.	64530.	194981.
REQN SAT		2050.	15447.	17497.
DMD	LL	154380.	73334.	227714.
	NLL	28807.	17011.	45818.
	ALL			273532.
FREQ	LL	3546.	20830.	24376.
	NLL	1742.	1963.	3705.
	ALL			28081.
NET UNIT EFF		0.8450	0.8233	0.8377
GROSS UNIT EFF		0.7121	0.6764	0.6994
NET REQN EFF		0.5732	0.7416	0.7175
GROSS REQN EFF		0.3877	0.6777	0.6231
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	3557	4150	7707
	NLL	9926	9040	18966
	ALL			26673
BRF X POP	LL	0	5510	5510
	NLL	0	107747	107747
	ALL			113257
FORCED FCST	LL	0	0	0
	NLL	1084	13244	14328
	ALL			14328
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	1345	1868	3213
	NLL	0	0	0
	ALL			3213
MIN RISK	LL	155	2908	3063
	NLL	0	0	0
	ALL			3063
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR MODEL WITH E=AQD



STATISTICS FOR MODEL WITH E=AQD

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.8012	0.5965	0.6653	0.3774
2	0.8076	0.6062	0.6390	0.3519
3	0.8200	0.6220	0.6420	0.3769
4	0.8070	0.6233	0.6435	0.3965
5	0.8299	0.6579	0.6367	0.4150
6	0.8010	0.6287	0.6129	0.3930
7	0.7953	0.6207	0.6197	0.3397
8	0.8000	0.5571	0.6521	0.4345
9	0.7957	0.6521	0.6633	0.3973
10	0.7594	0.5775	0.6400	0.3553
11	0.7542	0.5332	0.6257	0.3442
12	0.7559	0.5403	0.6256	0.3411
13	0.7785	0.6102	0.6337	0.3500
14	0.7705	0.5665	0.6074	0.3132
15	0.7772	0.5213	0.5922	0.2904
16	0.7661	0.5264	0.5891	0.2344
17	0.7503	0.5140	0.5911	0.2303
18	0.7765	0.5732	0.5961	0.2324
19	0.8049	0.6030	0.6036	0.2928
20	0.8007	0.6065	0.6177	0.3022
21	0.7511	0.5564	0.5735	0.3333
22	0.7510	0.5365	0.5594	0.2874
MEAN	0.7653	0.5921	0.6205	0.3425
S.DEV	0.0233	0.0433	0.0271	0.0455

APPENDIX E

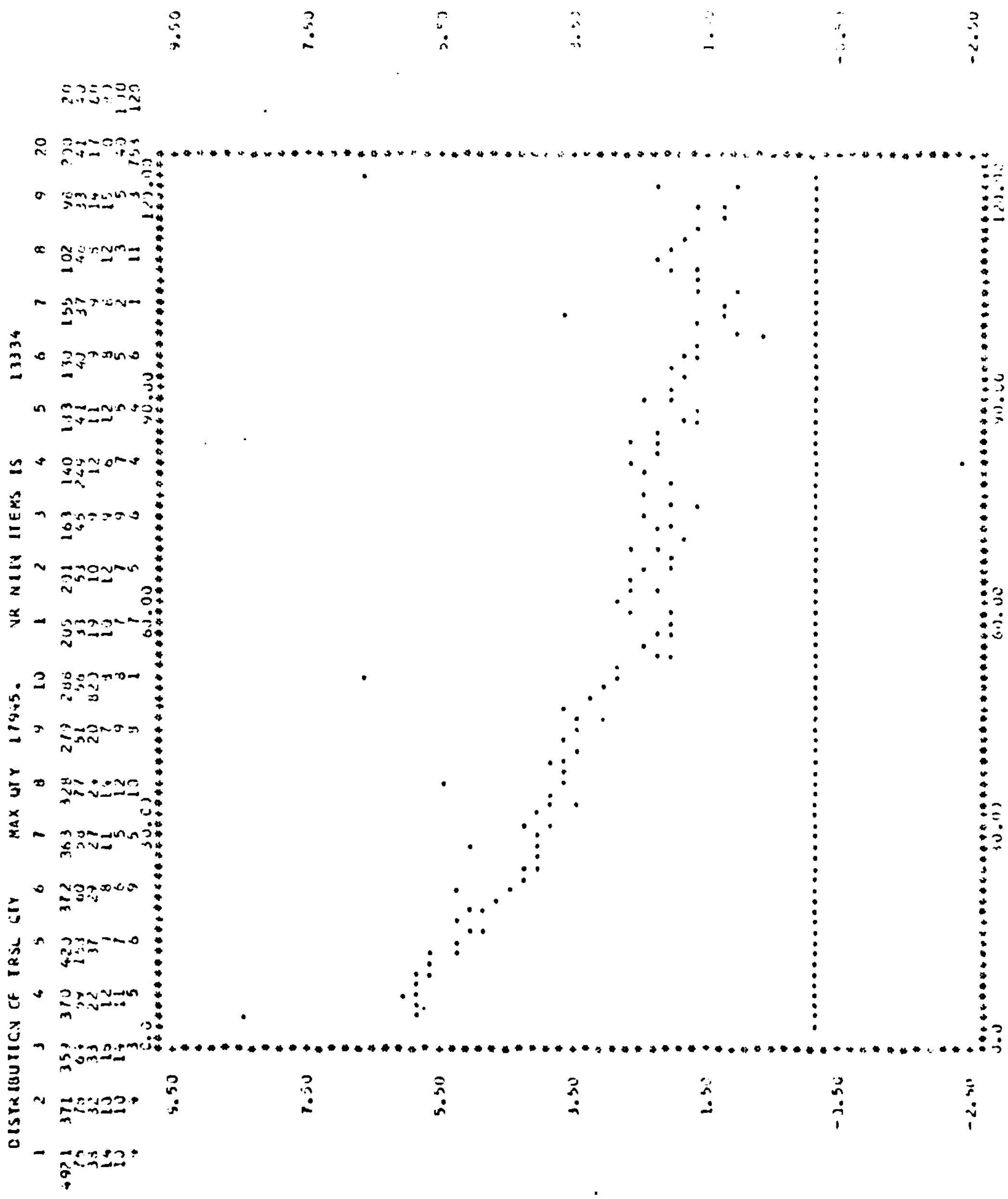
STATISTICS FOR MODEL WITH K3=0.6

TRSLL LOAD LIST OUTPUT STATISTICS

LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NER	ER	TOTAL
CANDIDATES		14567	139691	154258
LL RANGE		3557	9883	13440
LL VALUE		384927.	391644.	776572.
ADDS TO LL		3557	9883	13440
ADDS VALUE		384927.	391644.	776572.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		1540	3275	4815
CONSTRAINED QTY		0	683	683
EFFECTIVENESS DATA				
UNITS SAT		130451.	63541.	193992.
REQN SAT		2050.	14459.	16509.
DMD	LL	154380.	95424.	249803.
	NLL	28807.	17253.	46060.
	ALL			295863.
FREQ	LL	3546.	37899.	41444.
	NLL	1742.	1963.	3706.
	ALL			45150.
NET UNIT EFF		0.8450	0.6659	0.7766
GROSS UNIT EFF		0.7121	0.5639	0.6557
NET REQN EFF		0.5782	0.3815	0.3983
GROSS REQN EFF		0.3877	0.3627	0.3656
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	3557	4150	7707
	NLL	9926	9040	18966
	ALL			26673
BRF X POP	LL	0	5733	5733
	NLL	0	107601	107601
	ALL			113334
FORCED FCST	LL	0	0	0
	NLL	1084	13167	14251
	ALL			14251
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	1345	2844	4189
	NLL	0	0	0
	ALL			4189
MIN RISK	LL	166	1273	1444
	NLL	0	0	0
	ALL			1444
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR MODEL WITH K3=0.6



STATISTICS FOR MODEL WITH K3=0.6

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.8010	0.5965	0.6637	0.3765
2	0.8072	0.6057	0.6361	0.3505
3	0.8196	0.6213	0.6330	0.3758
4	0.8066	0.6280	0.6401	0.3953
5	0.8297	0.6577	0.6370	0.4043
6	0.8009	0.6237	0.6120	0.3936
7	0.7950	0.6205	0.6179	0.3359
8	0.8077	0.5569	0.5505	0.4052
9	0.7952	0.6517	0.6633	0.3959
10	0.7639	0.5775	0.5362	0.3649
11	0.7556	0.5579	0.5214	0.3421
12	0.7554	0.5403	0.5213	0.3395
13	0.7973	0.6099	0.6298	0.3342
14	0.7595	0.5580	0.6051	0.3112
15	0.7760	0.5209	0.5870	0.2330
16	0.7553	0.5255	0.5331	0.2321
17	0.7594	0.5142	0.5540	0.2775
18	0.7757	0.5777	0.5994	0.2704
19	0.8042	0.6025	0.5905	0.2595
20	0.7996	0.6555	0.5086	0.2973
21	0.7661	0.5557	0.5355	0.2993
22	0.7493	0.5357	0.5519	0.2342
MEAN	0.7865	0.5413	0.6161	0.3404
S.DEV	0.0234	0.0434	0.0287	0.0475

APPENDIX F

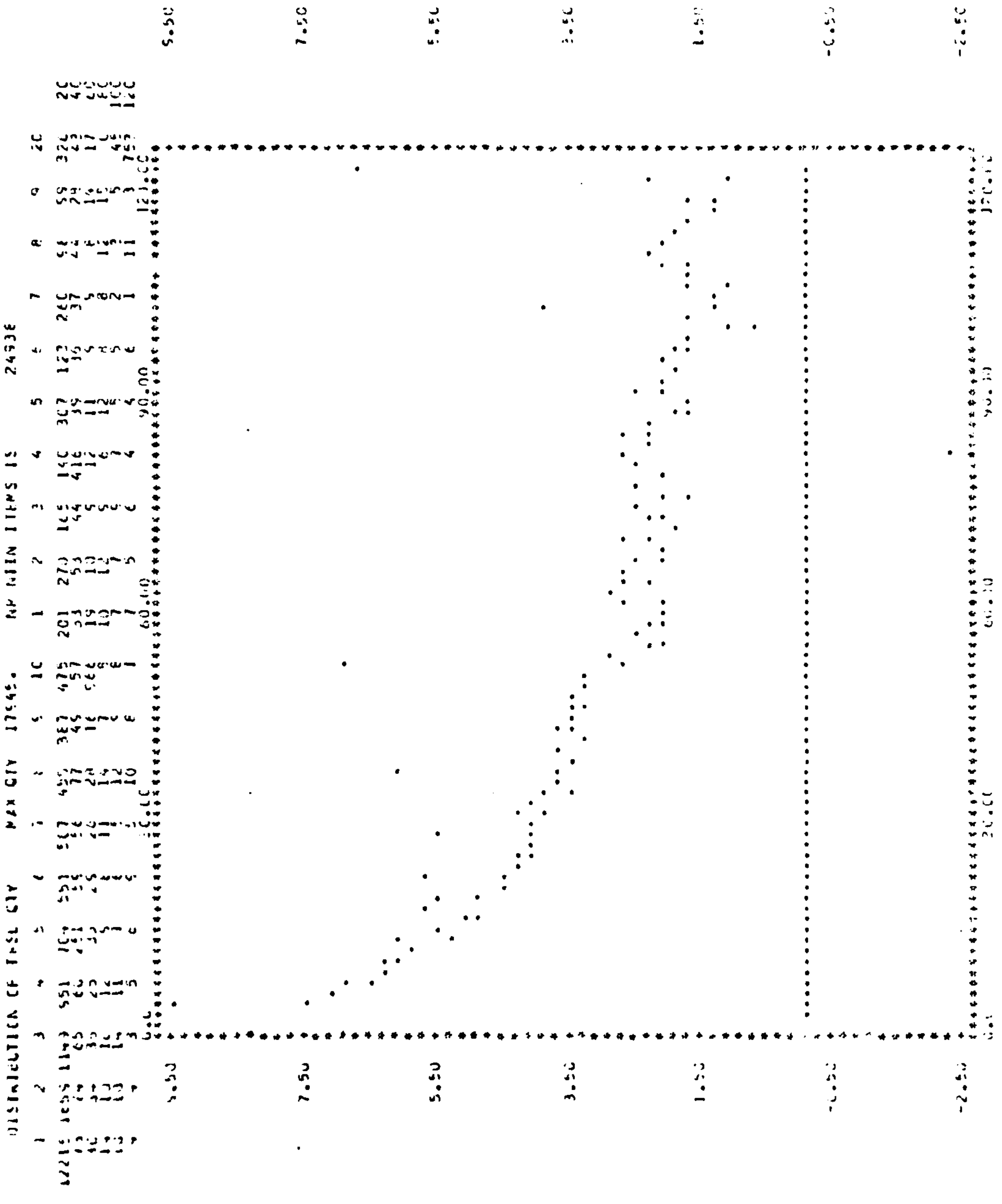
STATISTICS FOR MODEL WITH RC=4

TRSLL LEAD LIST OUTPUT STATISTICS

LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NEF	EF	TOTAL
CANDIDATES		14567	139691	154258
LL RANGE		4694	20532	25226
LL VALUE		485678.	1067147.	1552825.
ADDS TO LL		4694	20532	25226
ADDS VALUE		485678.	1067147.	1552825.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		2501	8883	11384
CONSTRAINED QTY		0	704	704
EFFECTIVENESS DATA				
UNITS SAT		130779.	68182.	198961.
RECN SAT		2224.	18260.	20484.
DMD	LL	155447.	100790.	256237.
	NLL	27739.	7900.	35639.
	ALL			291876.
FREQ	LL	4012.	41436.	45448.
	NLL	1277.	848.	2125.
	ALL			47573.
NET UNIT EFF		0.8413	0.6765	0.7765
GROSS UNIT EFF		0.7139	0.6273	0.6817
NET RECN EFF		0.5344	0.4407	0.4507
GROSS RECN EFF		0.4206	0.4318	0.4306
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	4694	7813	12507
	NLL	8789	5377	14166
	ALL			26673
BRF X POP	LL	0	12719	12719
	NLL	0	100538	100539
	ALL			113257
FORCED POST	LL	0	0	0
	NLL	1084	13244	14328
	ALL			14328
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	2248	7779	10027
	NLL	0	0	0
	ALL			10027
MIN RISK	LL	171	1893	2064
	NLL	0	0	0
	ALL			2064
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR MODEL WITH RC=4



STATISTICS FOR MODEL WITH RC=4

LOAD LIST EFFECTIVENESS   ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.7899	0.6045	0.6404	0.4430
2	0.7935	0.6131	0.6071	0.4136
3	0.8065	0.6279	0.6096	0.4233
4	0.7925	0.6332	0.6077	0.4309
5	0.8197	0.6622	0.6100	0.4434
6	0.7895	0.6330	0.5866	0.4299
7	0.7841	0.6247	0.5946	0.4278
8	0.7977	0.6615	0.6330	0.4477
9	0.7363	0.6565	0.6380	0.4364
10	0.7570	0.5831	0.6085	0.4064
11	0.7409	0.5442	0.5909	0.3861
12	0.7401	0.5455	0.5914	0.3834
13	0.7822	0.6167	0.5955	0.3772
14	0.7537	0.5736	0.5650	0.3457
15	0.7562	0.5258	0.5445	0.3209
16	0.7489	0.5298	0.5385	0.3148
17	0.7425	0.5184	0.5405	0.3128
18	0.7611	0.5820	0.5467	0.3148
19	0.7884	0.6067	0.5563	0.3240
20	0.7844	0.6097	0.5636	0.3314
21	0.7486	0.5893	0.5448	0.3335
22	0.7373	0.5898	0.5084	0.3155
MEAN	0.7728	0.5969	0.5828	0.3801
S.DEV	0.0245	0.0434	0.0362	0.0518

APPENDIX G

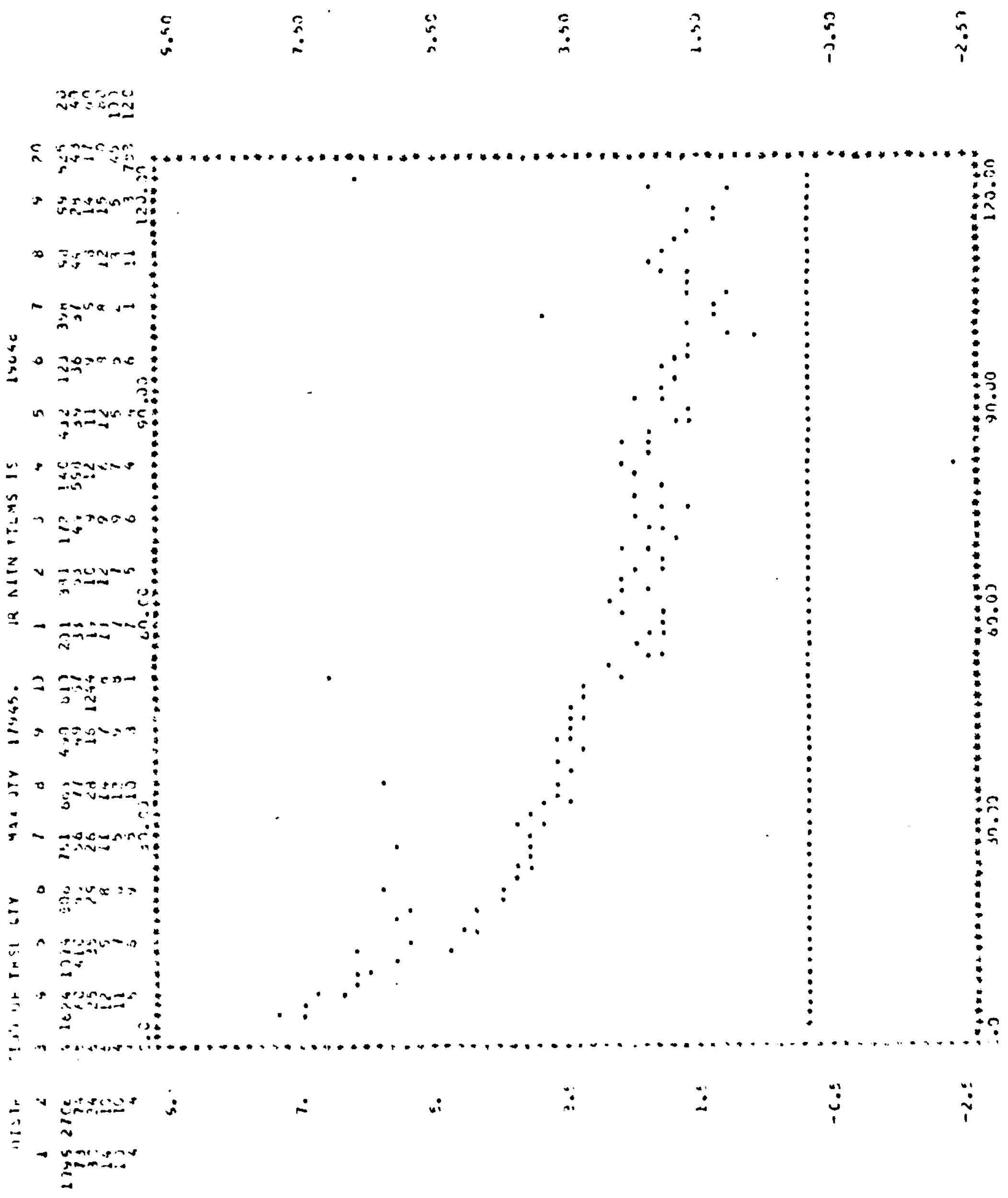
STATISTICS FOR NO-RANGE-CUT MODEL

TRSLL LOAD LIST OUTPUT STATISTICS

LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NER	EP	TOTAL
CANDIDATES		14567	139691	154258
LL RANGE		2156	17759	19915
LL VALUE		216394.	158641.	375035.
ADDS TO LL		2156	17759	19915
ADDS VALUE		216394.	158641.	375035.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		0	0	0
CONSTRAINED QTY		0	810	810
EFFECTIVENESS DATA				
UNITS SAT		130418.	67755.	198173.
REQN SAT		2026.	18193.	20219.
DMD	LL	141682.	76423.	218105.
	NLL	41504.	32242.	73746.
	ALL			291850.
FREQ	LL	2483.	22575.	25058.
	NLL	2805.	2981.	5786.
	ALL			30844.
NET UNIT EFF		0.9205	0.8866	0.9086
GROSS UNIT EFF		0.7119	0.6235	0.6790
NET REQN EFF		0.8160	0.8059	0.8069
GROSS REQN EFF		0.3832	0.7119	0.6555
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	2156	4277	6433
	NLL	11327	8913	20240
	ALL			26673
RFF X POP	LL	0	13482	13482
	NLL	0	99775	99775
	ALL			113257
FORCED FCST	LL	0	0	0
	NLL	1084	13244	14328
	ALL			14328
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	0	6	6
	NLL	2248	68262	70510
	ALL			70516
MIN RISK	LL	171	2998	3169
	NLL	0	1576	1576
	ALL			4745
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR NO-RANGE-CUT MODEL



STATISTICS FOR NO-RANGE-CUT MODEL

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.8451	0.5969	0.8295	0.3640
2	0.8484	0.6080	0.7941	0.3457
3	0.8576	0.6235	0.8023	0.3592
4	0.8360	0.6293	0.7934	0.3773
5	0.8597	0.6578	0.7983	0.3861
6	0.8328	0.6287	0.7790	0.3677
7	0.8247	0.6204	0.7723	0.3618
8	0.8350	0.6576	0.8019	0.3783
9	0.8269	0.6515	0.8145	0.3658
10	0.8062	0.5776	0.7987	0.3405
11	0.7842	0.5399	0.7737	0.3224
12	0.7776	0.5418	0.7733	0.3215
13	0.8192	0.6127	0.7738	0.3196
14	0.7871	0.5703	0.7410	0.2978
15	0.7977	0.5227	0.7216	0.2777
16	0.7855	0.5269	0.7171	0.2729
17	0.7785	0.5156	0.7117	0.2699
18	0.7944	0.5789	0.7146	0.2706
19	0.8240	0.6033	0.7227	0.2795
20	0.8220	0.6063	0.7284	0.2867
21	0.7831	0.5864	0.7066	0.2893
22	0.7752	0.5865	0.6817	0.2747
MEAN	0.8137	0.5928	0.7614	0.3240
S.DEV	0.0277	0.0430	0.0420	0.0418

APPENDIX H

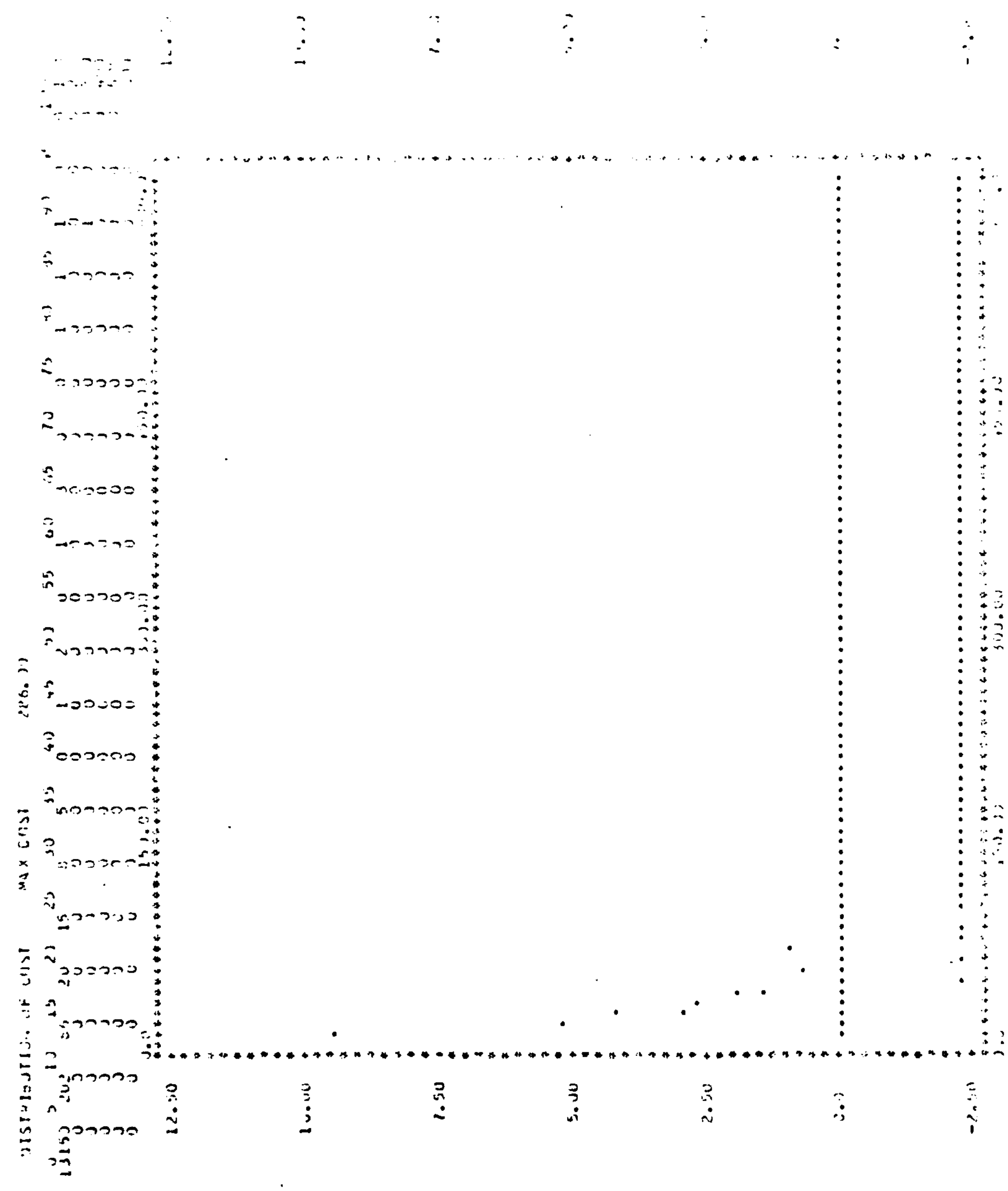
STATISTICS FOR MODIFIED NO-RANGE-CUT MODEL

TROLL LOAD LIST OUTPUT STATISTICS

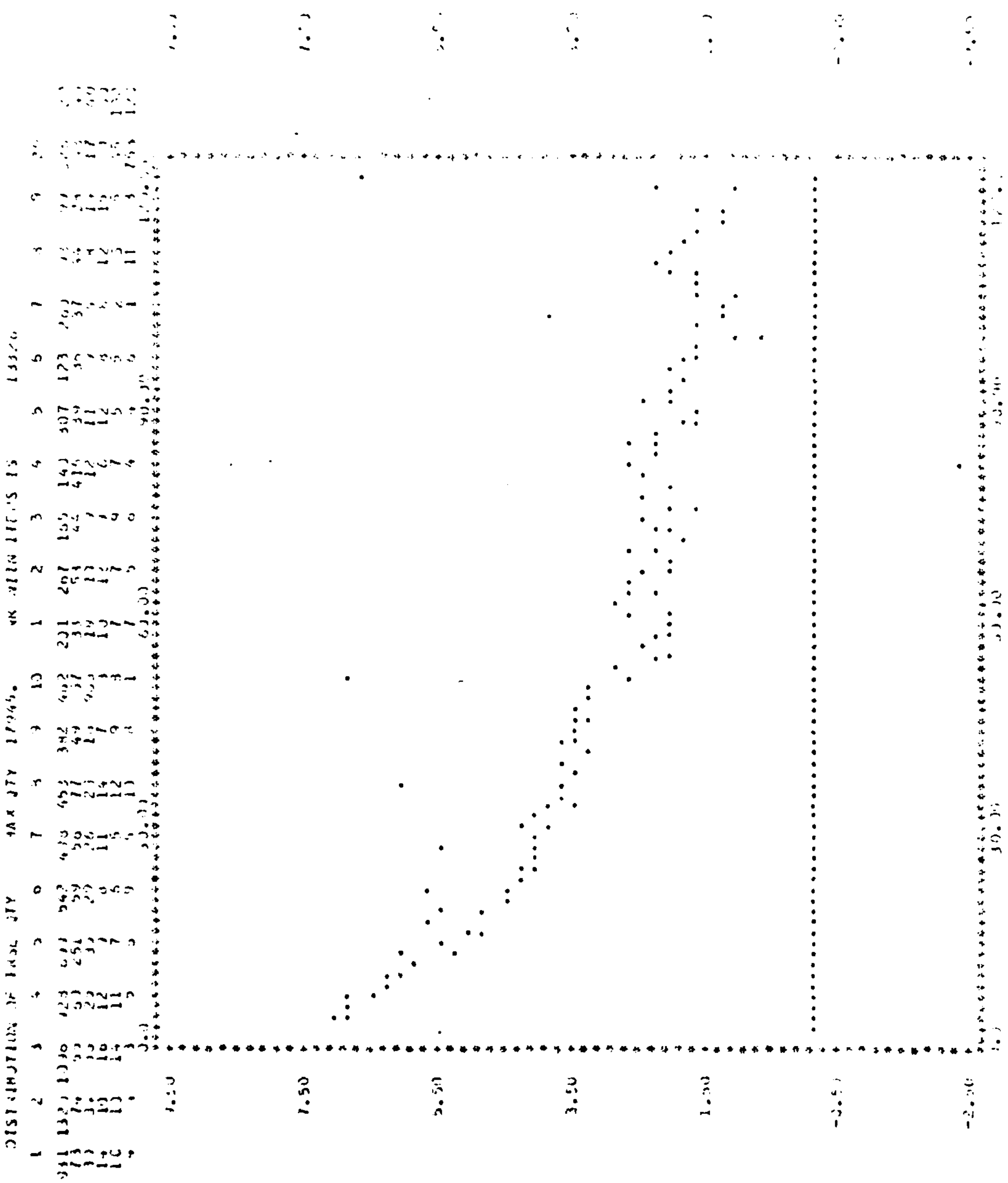
LE = 0.154 LA = 0.154 T = 1.0 K13 = 1.

	NER	ER	TOTAL
CANDIDATES	14537	139691	154233
LL RANGE	2156	11321	13477
LL VALUE	215394.	150361.	365755.
ADDS TO LL	2156	11321	13477
ADDS VALUE	215394.	150361.	365755.
DELETES FM LL	0	0	0
DELETES VALUE	0.	0.	0.
FORCED ON LL	0	0	0
CONSTRAINED QTY	0	704	704
EFFECTIVENESS DATA			
UNITS SAT	130418.	66141.	196559.
REQN SAT	2025.	16598.	18624.
DMD LL	141682.	74747.	216429.
NLL	41504.	33974.	75478.
ALL			291907.
FREQ LL	2483.	20907.	23390.
NLL	2305.	3050.	5355.
ALL			28745.
NET UNIT EFF	0.9205	0.6549	0.9032
GROSS UNIT EFF	0.7119	0.6084	0.6734
NET REQN EFF	0.8150	0.7930	0.7962
GROSS REQN EFF	0.3332	0.5925	0.6356
AVERAGE DEMAND COMPUTATION			
HISTORICAL DMD LL	2156	3867	6023
NLL	11327	9323	20650
ALL			26673
BRF X POP LL	0	7454	7454
NLL	0	105803	105803
ALL			113257
FORCED FCST LL	0	0	0
NLL	1084	13244	14328
ALL			14328
NUMBER OF ITEMS RISK CONSTRAINED			
MAX RISK LL	0	3	3
NLL	2248	7773	10021
ALL			10024
MIN RISK LL	171	1893	2064
NLL	0	0	0
ALL			2064
OVERRIDES APPLIED			
MANDATORY	0	0	0
MAX QTY	0	0	0
MIN QTY	0	0	0
DELETE	0	0	0

STATISTICS FOR MODIFIED NO-RANGE-CUT MODEL



STATISTICS FOR MODIFIED NO-RANGE-CUT MODEL



STATISTICS FOR MODIFIED NO-RANGE-CUT MODEL

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.8468	0.5952	0.8326	0.3567
2	0.8512	0.6057	0.7989	0.3359
3	0.8621	0.6209	0.8031	0.3508
4	0.8421	0.6270	0.8002	0.3704
5	0.8564	0.6560	0.8032	0.3798
6	0.8577	0.6272	0.7839	0.3628
7	0.8510	0.6103	0.7764	0.3565
8	0.8340	0.6558	0.8059	0.3727
9	0.8261	0.6407	0.8160	0.3567
10	0.8082	0.5755	0.8024	0.3311
11	0.7859	0.5375	0.7789	0.3127
12	0.7813	0.5393	0.7816	0.3138
13	0.8223	0.6104	0.7800	0.3127
14	0.7908	0.5584	0.7463	0.2914
15	0.8016	0.5210	0.7265	0.2715
16	0.7901	0.5255	0.7207	0.2558
17	0.7840	0.5142	0.7176	0.2633
18	0.7994	0.5774	0.7186	0.2542
19	0.8273	0.6019	0.7281	0.2732
20	0.8240	0.6048	0.7327	0.2796
21	0.7857	0.5850	0.7116	0.2329
22	0.7776	0.5653	0.6848	0.2653
MEAN	0.8176	0.5911	0.7662	0.3170
S.DEV	0.0280	0.0425	0.0420	0.0415

APPENDIX I

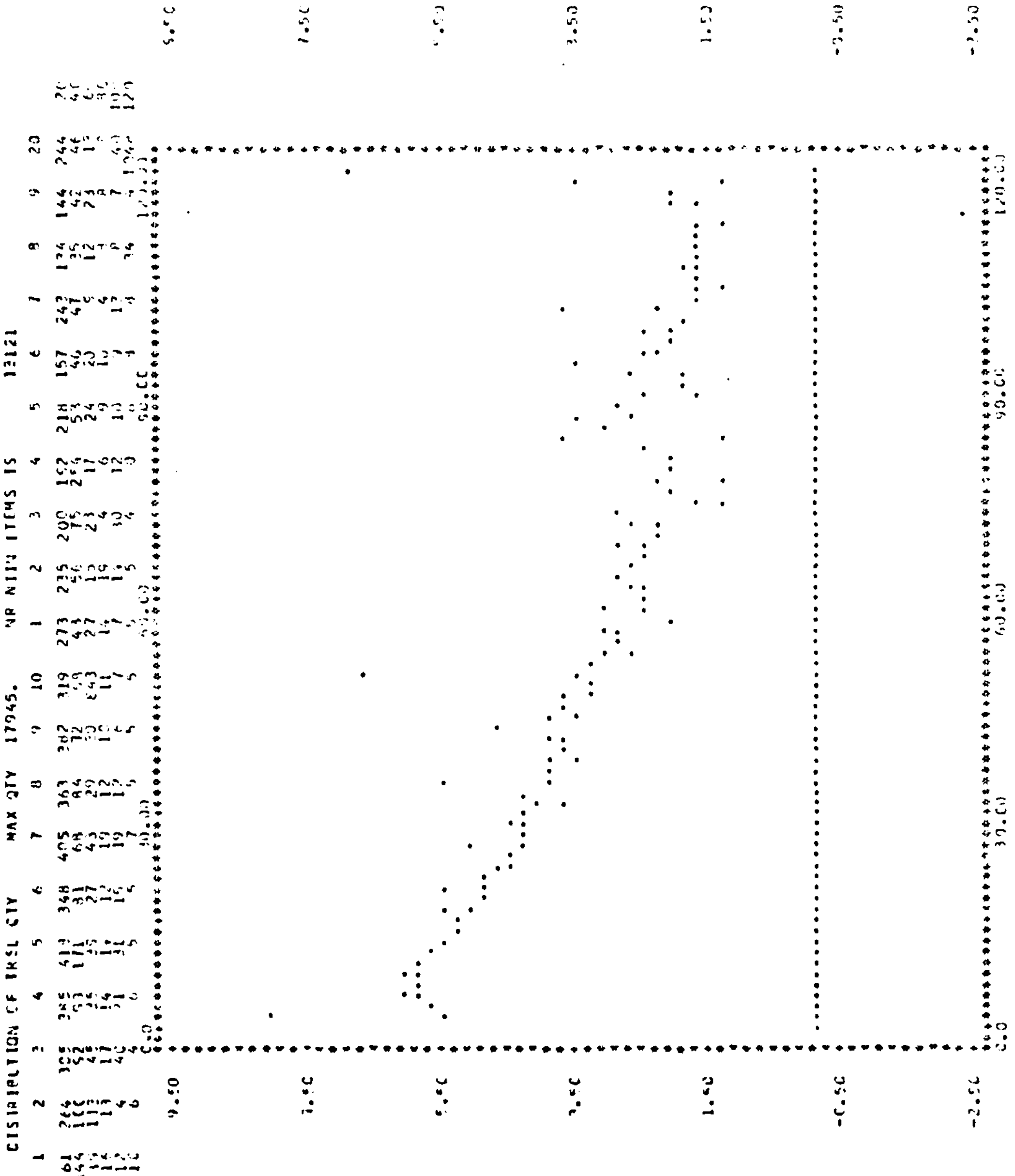
STATISTICS FOR MODEL WITH A=1

TRSLL LOAD LIST OUTPUT STATISTICS

LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NER	ER	TOTAL
CANDIDATES		14567	139691	154258
LL RANGE		3557	9660	13217
LL VALUE		885562.	515954.	1401516.
ADDS TO LL		3557	9660	13217
ADDS VALUE		885562.	515954.	1401516.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		520	2500	3020
CONSTRAINED QTY		0	680	680
EFFECTIVENESS DATA				
UNITS SAT		149392.	69132.	218524.
REQN SAT		2874.	14735.	17610.
DMD	LL	154380.	91118.	245498.
	NLL	28807.	17011.	45818.
	ALL			291316.
FREQ	LL	3546.	34222.	37767.
	NLL	1742.	1963.	3706.
	ALL			41473.
NET UNIT EFF		0.9677	0.7587	0.8901
GROSS UNIT EFF		0.8155	0.6393	0.7501
NET REQN EFF		0.8106	0.4306	0.4663
GROSS REQN EFF		0.5436	0.4072	0.4246
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	3557	4150	7707
	NLL	9926	9040	18966
	ALL			26673
BFF X PCP	LL	0	5510	5510
	NLL	0	107747	107747
	ALL			113257
FORCED FCST	LL	0	0	0
	NLL	1084	13244	14328
	ALL			14328
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	427	2179	2606
	NLL	0	0	0
	ALL			2606
MIN RISK	LL	1438	2601	4039
	NLL	0	0	0
	ALL			4039
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR MODEL WITH A=1



STATISTICS FOR MODEL WITH A=1

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.8614	0.6407	0.7929	0.4510
2	0.8751	0.6553	0.7786	0.4412
3	0.8824	0.6684	0.7716	0.4531
4	0.8642	0.6723	0.7702	0.4743
5	0.8843	0.7003	0.7604	0.4819
6	0.8605	0.6743	0.7448	0.4783
7	0.8576	0.6687	0.7524	0.4726
8	0.8674	0.7057	0.7896	0.4944
9	0.8554	0.7009	0.7923	0.4748
10	0.8376	0.6261	0.7741	0.4436
11	0.8218	0.5827	0.7699	0.4236
12	0.8212	0.5838	0.7750	0.4221
13	0.8586	0.6553	0.7866	0.4166
14	0.8286	0.6109	0.7616	0.3925
15	0.8393	0.5625	0.7473	0.3666
16	0.8207	0.5643	0.7416	0.3568
17	0.8188	0.5546	0.7341	0.3486
18	0.8354	0.6213	0.7415	0.3513
19	0.8625	0.6456	0.7489	0.3633
20	0.8605	0.6516	0.7655	0.3746
21	0.8125	0.6259	0.7408	0.3769
22	0.8041	0.6281	0.7038	0.3621
MEAN	0.8468	0.6364	0.7611	0.4193
S.DEV	0.0237	0.0453	0.0222	0.0498

APPENDIX J

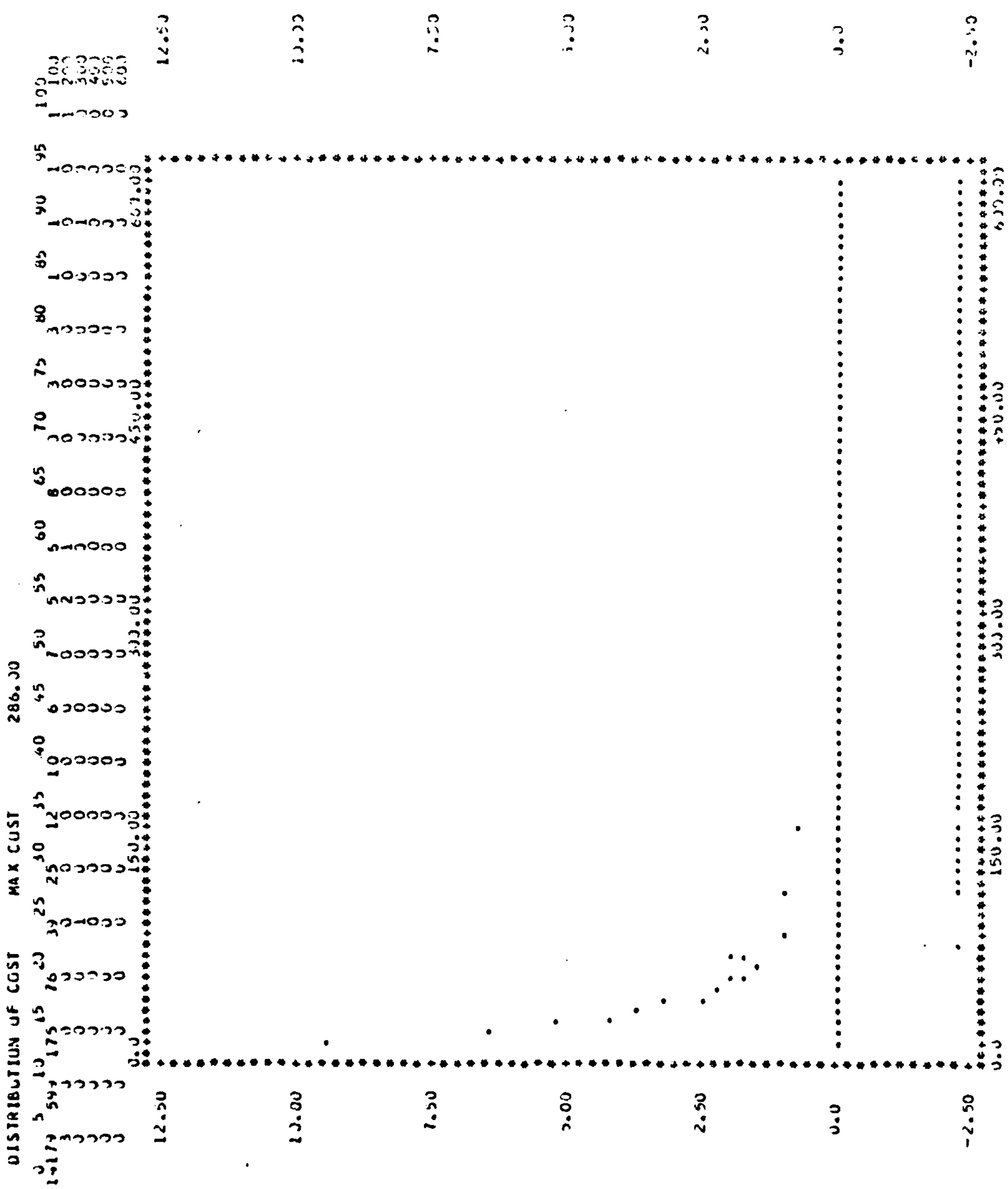
STATISTICS FOR 1980 TARSLL MODEL

TRSLL LOAD LIST OUTPUT STATISTICS

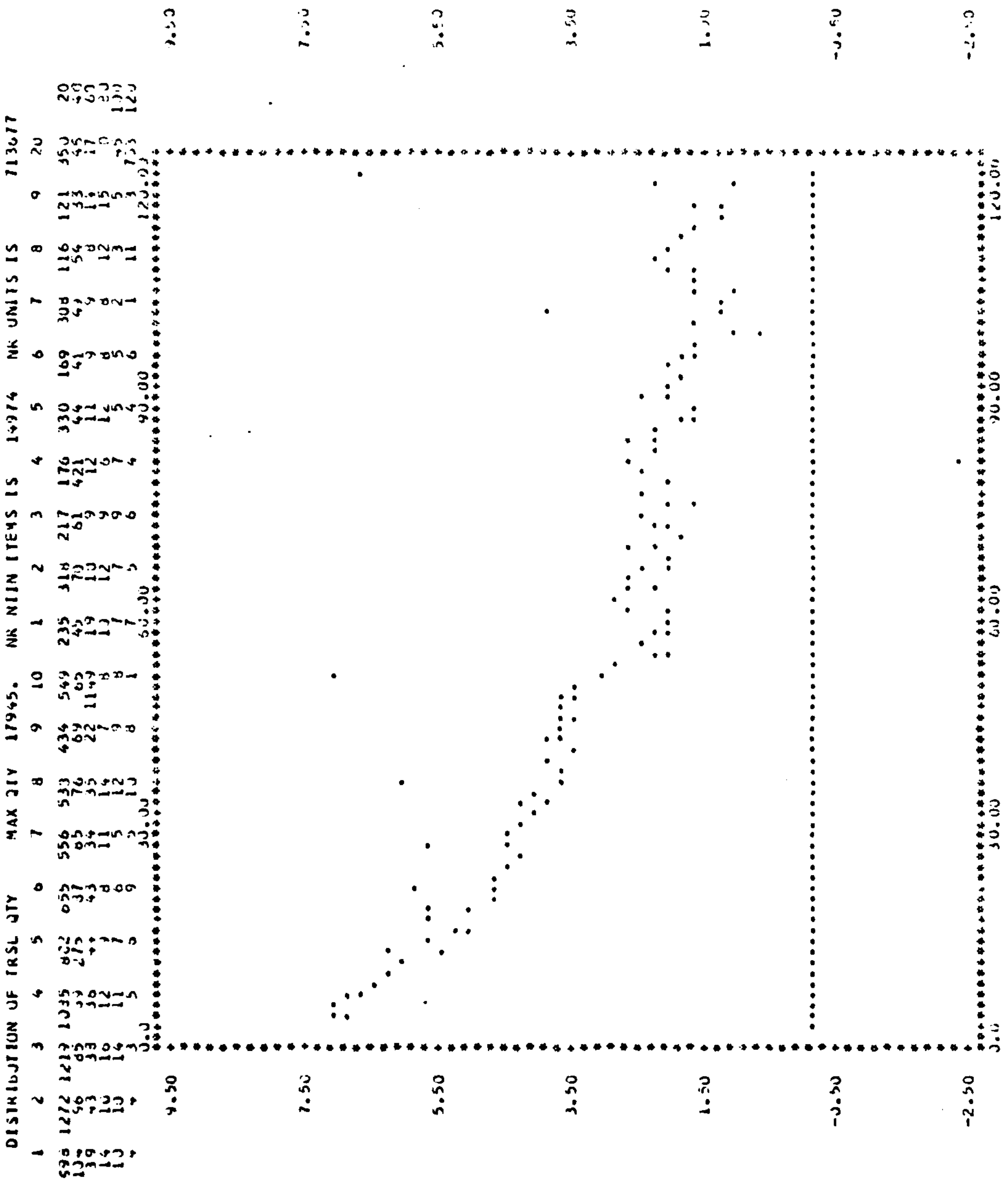
LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NER	ER	TOTAL
CANDIDATES		14567	139691	154258
LL RANGE		2156	13010	15166
LL VALUE		216394.	227917.	444311.
ADDS TO LL		2156	13010	15166
ADDS VALUE		216394.	227917.	444311.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		0	0	0
CONSTRAINED QTY		0	1283	1283
EFFECTIVENESS DATA				
UNITS SAT		130418.	68422.	198840.
REQN SAT		2026.	18895.	20921.
DMD	LL	141682.	75016.	216698.
	NLL	41504.	21160.	62664.
	ALL			279362.
FREQ	LL	2483.	21183.	23666.
	NLL	2805.	3050.	5855.
	ALL			29520.
NET UNIT EFF		0.9205	0.9121	0.9176
GROSS UNIT EFF		0.7119	0.7114	0.7118
NET REQN EFF		0.8150	0.8920	0.8840
GROSS REQN EFF		0.3832	0.7797	0.7087
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	2156	3867	6023
	NLL	11327	9323	20650
	ALL			26673
BRF X POP	LL	0	9143	9143
	NLL	0	104191	104191
	ALL			113334
FORCED FCST	LL	0	0	0
	NLL	1084	13167	14251
	ALL			14251
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	0	6	6
	NLL	2248	6667	8915
	ALL			8921
MIN RISK	LL	171	3876	4047
	NLL	0	0	0
	ALL			4047
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR 1980 TARSLL MODEL



STATISTICS FOR 1980 TARSLL MODEL



STATISTICS FOR 1980 TARSLL MODEL

LOAD LIST EFFECTIVENESS   ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.8462	0.5955	0.8327	0.3588
2	0.8508	0.6060	0.7981	0.3394
3	0.8617	0.5213	0.8082	0.3533
4	0.8418	0.6275	0.8006	0.3728
5	0.8660	0.6563	0.8031	0.3817
6	0.8388	0.6274	0.7839	0.3644
7	0.8303	0.6192	0.7766	0.3538
8	0.8384	0.6563	0.8057	0.3754
9	0.8283	0.6503	0.8168	0.3604
10	0.8079	0.5750	0.8044	0.3346
11	0.7869	0.5381	0.7816	0.3167
12	0.7815	0.5403	0.7823	0.3171
13	0.8224	0.6111	0.7810	0.3160
14	0.7906	0.5691	0.7485	0.2945
15	0.8017	0.5213	0.7286	0.2751
16	0.7900	0.5264	0.7218	0.2709
17	0.7841	0.5149	0.7187	0.2680
18	0.7996	0.5782	0.7201	0.2691
19	0.8274	0.6025	0.7302	0.2787
20	0.8246	0.6059	0.7340	0.2865
21	0.7853	0.5851	0.7119	0.2868
22	0.7772	0.5866	0.6854	0.2744
MEAN	0.8173	0.5917	0.7670	0.3207
S.DEV	0.0279	0.0428	0.0416	0.0404

APPENDIX K

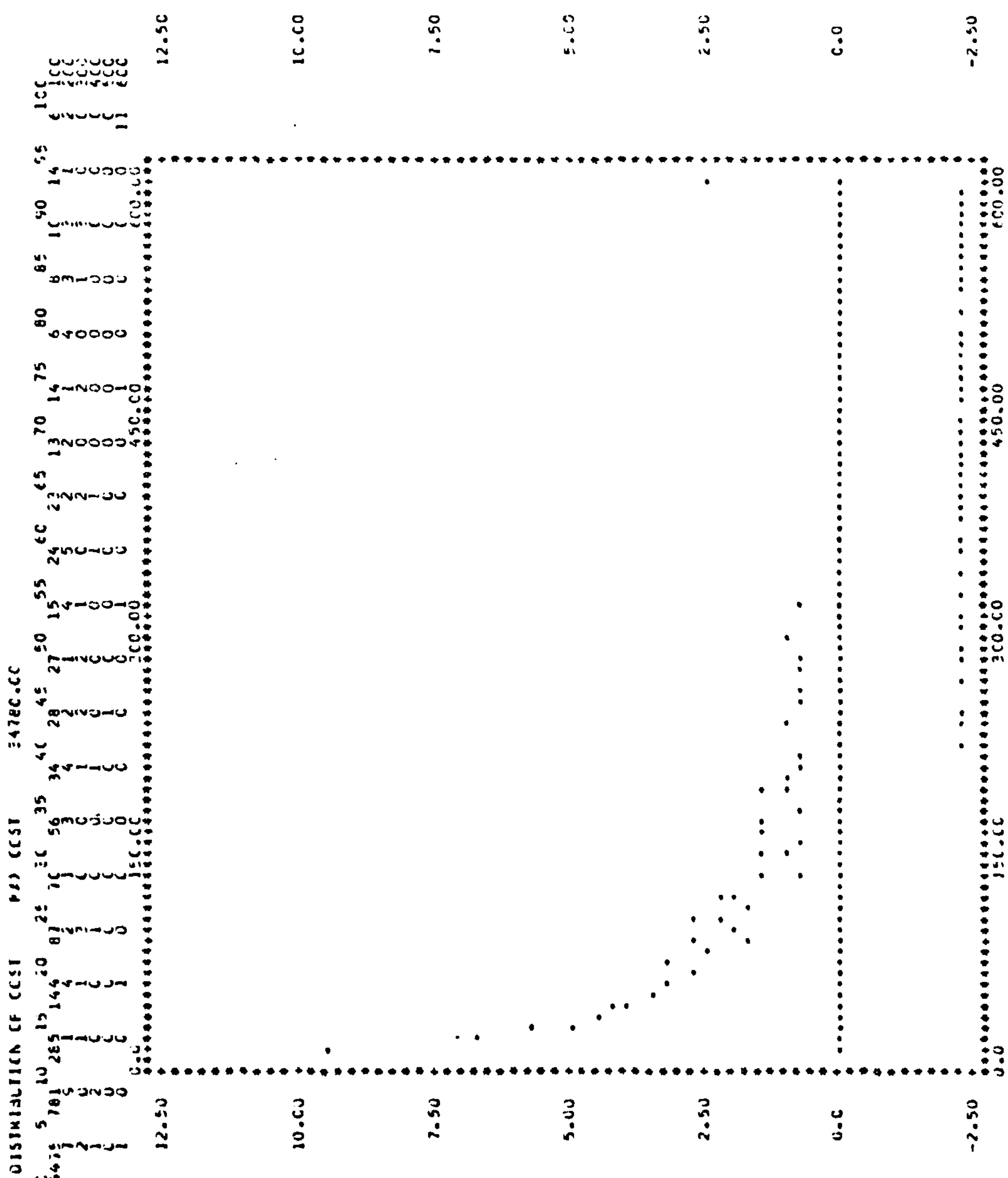
STATISTICS FOR AS-FBM MODEL

TRSLL LOAD LIST OUTPUT STATISTICS

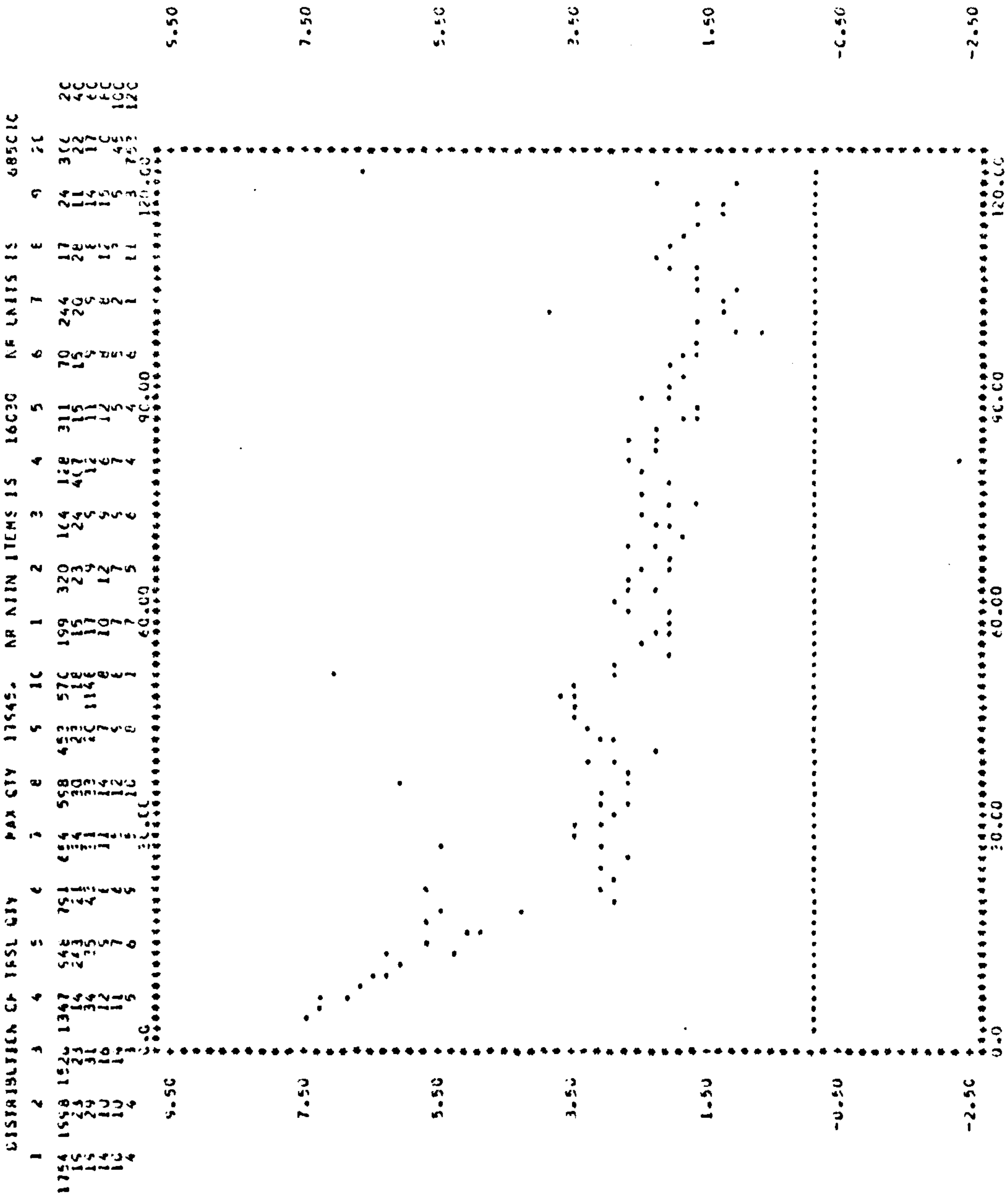
LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NEF	ER	TOTAL
CANDIDATES		14567	139691	154258
LL RANGE		2687	13538	16225
LL VALUE		302505.	252988.	555493.
ADDS TO LL		2687	13538	16225
ADDS VALUE		302505.	252988.	555493.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		0	0	0
CONSTRAINED QTY		0	1250	1250
EFFECTIVENESS DATA				
UNITS SAT		132457.	71903.	204360.
RECN SAT		2296.	20750.	23046.
DMD	LL	144654.	78080.	222734.
	NLL	38532.	18361.	56894.
	ALL			279627.
FREQ	LL	2913.	22689.	25602.
	NLL	2375.	2511.	4886.
	ALL			30488.
NET UNIT EFF		0.9157	0.9209	0.9175
GROSS UNIT EFF		0.7231	0.7456	0.7308
NET RECN EFF		0.7883	0.9145	0.9002
GROSS REQN EFF		0.4343	0.8234	0.7559
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	2687	4287	6974
	NLL	10796	8903	19699
	ALL			26673
BRF X PCP	LL	0	9251	9251
	NLL	0	104083	104083
	ALL			113334
FORCED FCST	LL	0	0	0
	NLL	1084	13167	14251
	ALL			14251
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	382	366	748
	NLL	1866	6307	8173
	ALL			8921
MIN RISK	LL	171	3876	4047
	NLL	0	0	0
	ALL			4047
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR AS-FBM MODEL



STATISTICS FOR AS-FBM MODEL



STATISTICS FOR AS-FBM MODEL

LOAD LIST EFFECTIVENESS   ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REGN	GROSS REGN
1	0.8254	0.5942	0.7411	0.3638
2	0.8306	0.6044	0.7199	0.3470
3	0.8413	0.6197	0.7277	0.3610
4	0.8216	0.6260	0.7256	0.3801
5	0.8463	0.6555	0.7247	0.3895
6	0.8192	0.6267	0.7088	0.3761
7	0.8130	0.6181	0.7057	0.3715
8	0.8256	0.6551	0.7430	0.3920
9	0.8169	0.6497	0.7511	0.3794
10	0.7918	0.5751	0.7229	0.3483
11	0.7702	0.5364	0.6980	0.3259
12	0.7660	0.5385	0.7006	0.3274
13	0.8059	0.6089	0.7052	0.3243
14	0.7747	0.5660	0.6723	0.3002
15	0.7843	0.5183	0.6534	0.2794
16	0.7741	0.5233	0.6424	0.2735
17	0.7573	0.5118	0.6418	0.2701
18	0.7826	0.5752	0.6406	0.2696
19	0.8094	0.5993	0.6521	0.2793
20	0.8073	0.6023	0.6562	0.2864
21	0.7715	0.5836	0.6440	0.2917
22	0.7625	0.5840	0.6091	0.2765
MEAN	0.8004	0.5896	0.6903	0.3279
S.DEV	0.0266	0.0434	0.0414	0.0445

APPENDIX L

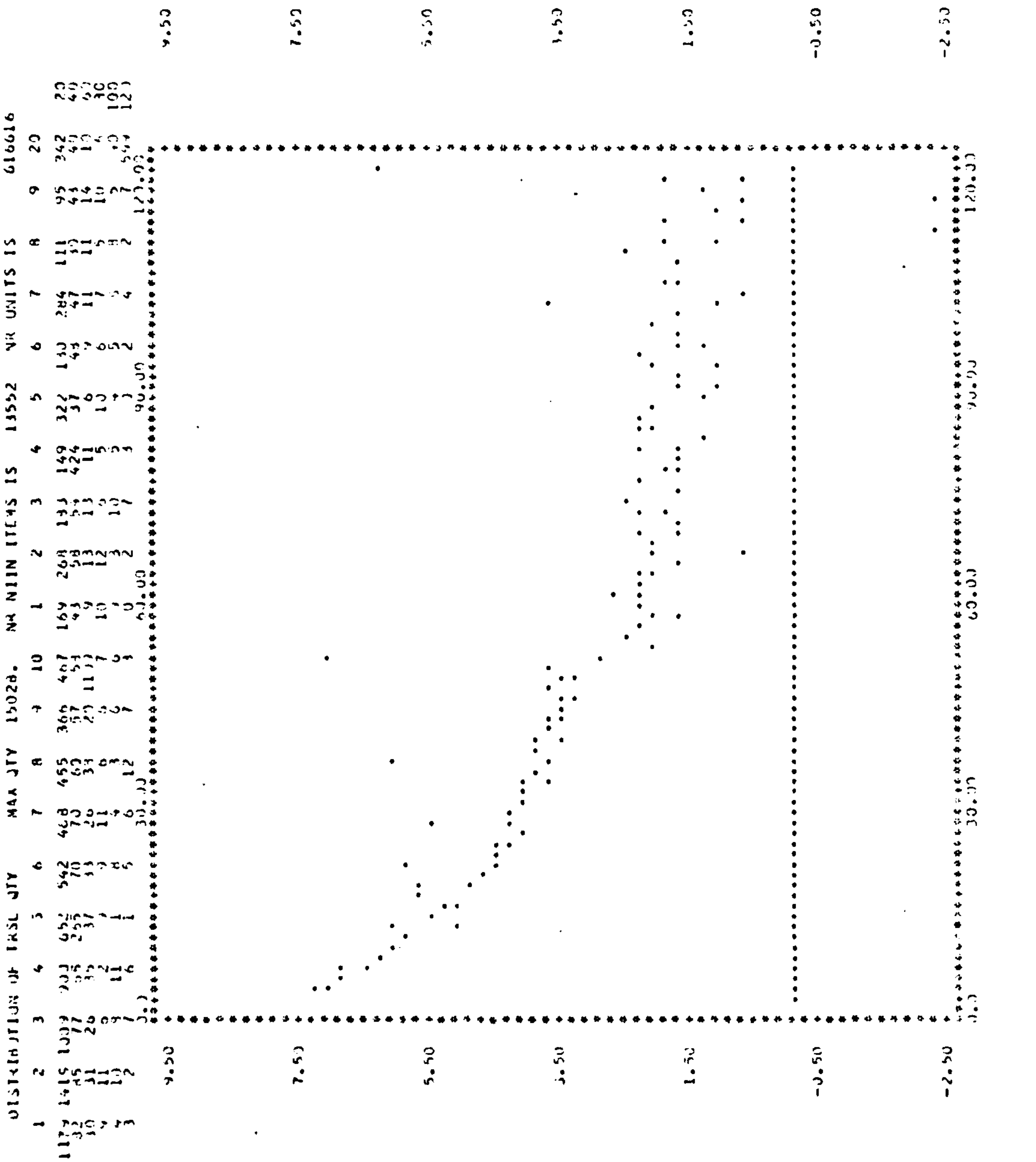
STATISTICS FOR MODEL WITH GAMMA DISTRIBUTION

TRSLL LOAD LIST OUTPUT STATISTICS

LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NER	ER	TOTAL
CANDIDATES		14567	139691	154258
LL RANGE		2089	11615	13704
LL VALUE		153442.	177072.	330514.
ADDS TO LL		2089	11615	13704
ADDS VALUE		153442.	177072.	330514.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		0	0	0
CONSTRAINED QTY		0	1156	1156
EFFECTIVENESS DATA				
UNITS SAT		116239.	62166.	178405.
REQN SAT		1619.	17006.	18624.
DMD	LL	143433.	75969.	219402.
	NLL	39753.	21516.	61268.
	ALL			280671.
FREQ	LL	2577.	21269.	23846.
	NLL	2712.	2982.	5693.
	ALL			29539.
NET UNIT EFF		0.8104	0.8133	0.8131
GROSS UNIT EFF		0.6345	0.6377	0.6356
NET REQN EFF		0.6282	0.7995	0.7810
GROSS REQN EFF		0.3061	0.7012	0.6305
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	2089	3475	5564
	NLL	11394	9715	21109
	ALL			26573
BRF X POP	LL	0	8140	8140
	NLL	0	105194	105194
	ALL			113334
FORCED FCST	LL	0	0	0
	NLL	1084	13167	14251
	ALL			14251
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	38	49	87
	NLL	2210	6624	8334
	ALL			8921
MIN RISK	LL	171	3876	4047
	NLL	0	0	0
	ALL			4047
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR MODEL WITH GAMMA DISTRIBUTION



STATISTICS FOR MODEL WITH GAMMA DISTRIBUTION

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.7970	0.5670	0.7304	0.3233
2	0.8013	0.5769	0.7097	0.3087
3	0.8145	0.5907	0.7242	0.3241
4	0.7968	0.5977	0.7097	0.3405
5	0.8150	0.5214	0.7114	0.3482
6	0.7830	0.5902	0.6919	0.3355
7	0.7772	0.5833	0.6955	0.3330
8	0.7359	0.6191	0.7210	0.3517
9	0.7714	0.6131	0.7236	0.3357
10	0.7639	0.5520	0.7147	0.3086
11	0.7423	0.5137	0.6949	0.2833
12	0.7414	0.5145	0.6964	0.2884
13	0.7365	0.5859	0.6974	0.2882
14	0.7536	0.5441	0.6628	0.2643
15	0.7609	0.4973	0.6422	0.2442
16	0.7451	0.4980	0.6353	0.2390
17	0.7384	0.4865	0.6371	0.2370
18	0.7555	0.5486	0.6413	0.2378
19	0.7331	0.5724	0.6465	0.2470
20	0.7371	0.5786	0.6562	0.2560
21	0.7398	0.5536	0.6316	0.2555
22	0.7308	0.5524	0.6077	0.2439
MEAN	0.7713	0.5617	0.6813	0.2909
S.DEV	0.0256	0.0393	0.0378	0.0414

APPENDIX M

STATISTICS FOR UNITS SATISFIED MODEL

TRSLL LOAD LIST OUTPUT STATISTICS

LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

	NER	ER	TOTAL
CANDIDATES	14567	139691	154258
LL RANGE	2708	13674	16382
LL VALUE	167606.	123189.	290795.
ADDS TO LL	2708	13674	16382
ADDS VALUE	167606.	123189.	290795.
DELETES FM LL	0	0	0
DELETES VALUE	0.	0.	0.
FORCED ON LL	0	0	0
CONSTRAINED QTY	0	324	324

EFFECTIVENESS DATA

		NER	ER	TOTAL
UNITS SAT		131019.	67272.	198291.
REQN SAT		1626.	18402.	20028.
DMD	LL	143077.	76951.	220028.
	NLL	40109.	31269.	71378.
	ALL			291406.
FREQ	LL	2127.	22956.	25083.
	NLL	3166.	3273.	6439.
	ALL			31522.
NET UNIT EFF		0.9157	0.8742	0.9012
GROSS UNIT EFF		0.7152	0.6215	0.6805
NET REQN EFF		0.7647	0.8016	0.7985
GROSS REQN EFF		0.3075	0.7015	0.6354

AVERAGE DEMAND COMPUTATION

		NER	ER	TOTAL
HISTORICAL DMD	LL	2708	4981	7689
	NLL	10775	8209	18984
	ALL			26673
BRF X PCP	LL	0	8693	8693
	NLL	0	104641	104641
	ALL			113334
FORCED FCST	LL	0	0	0
	NLL	1084	13167	14251
	ALL			14251

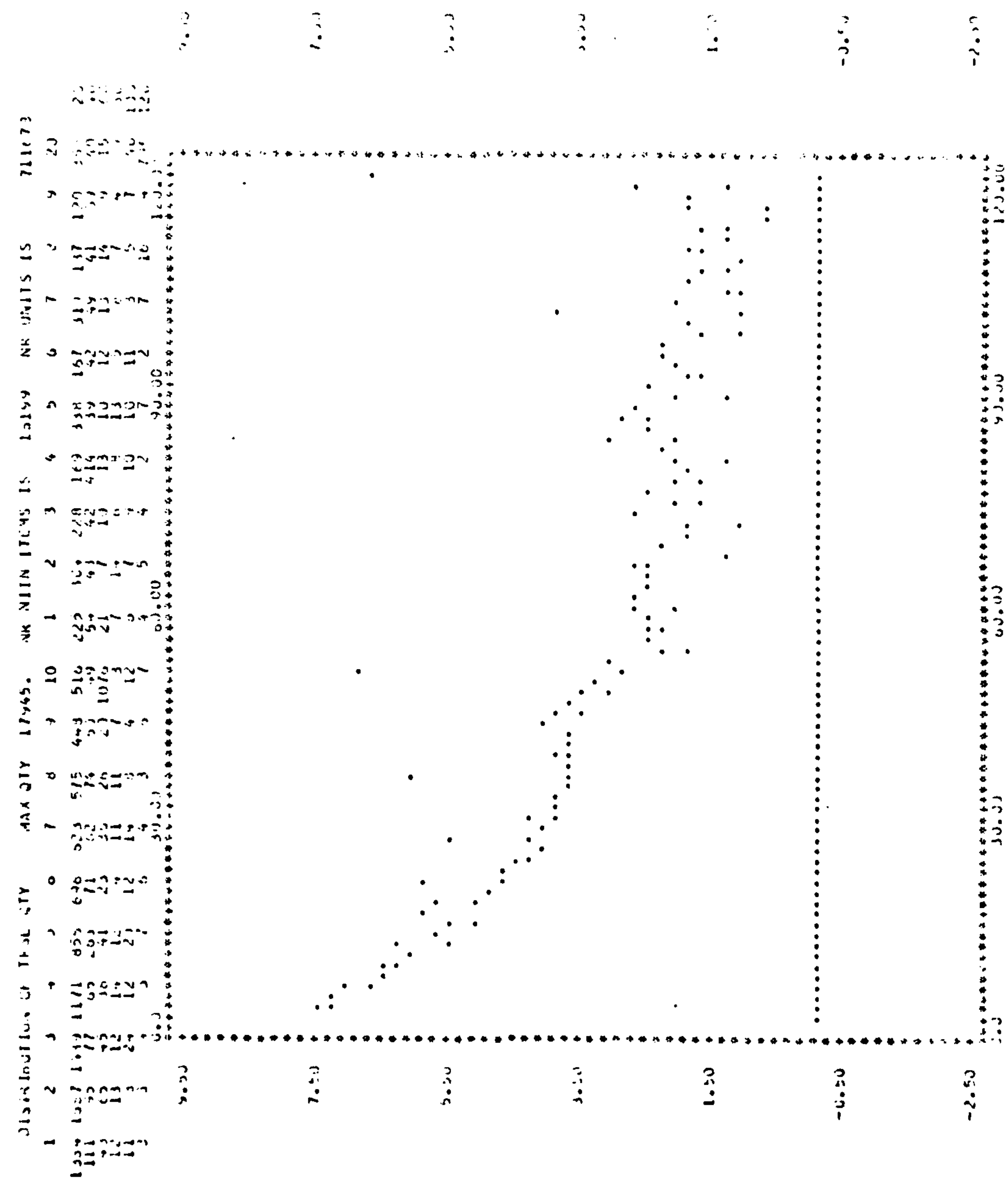
NUMBER OF ITEMS RISK CONSTRAINED

		NER	ER	TOTAL
MAX RISK	LL	9	20	29
	NLL	1700	6011	7711
	ALL			7740
MIN RISK	LL	273	3377	3650
	NLL	0	0	0
	ALL			3650

OVERRIDES APPLIED

	NER	ER	TOTAL
MANDATORY	0	0	0
MAX QTY	0	0	0
MIN QTY	0	0	0
DELETE	0	0	0

STATISTICS FOR UNITS SATISFIED MODEL



STATISTICS FOR UNITS SATISFIED MODEL

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.8249	0.5738	0.7389	0.2829
2	0.8329	0.5929	0.7144	0.2728
3	0.8440	0.6071	0.7188	0.2754
4	0.8219	0.6133	0.7016	0.2848
5	0.8467	0.6388	0.7237	0.2685
6	0.8165	0.6102	0.7199	0.2742
7	0.8072	0.6020	0.7186	0.2701
8	0.8247	0.6461	0.7396	0.2335
9	0.8157	0.6386	0.7443	0.2712
10	0.7962	0.5625	0.7281	0.2535
11	0.7796	0.5315	0.7145	0.2518
12	0.7782	0.5392	0.7113	0.2625
13	0.8167	0.6112	0.7163	0.2723
14	0.7349	0.5668	0.6745	0.2498
15	0.7893	0.5183	0.6436	0.2276
16	0.7816	0.5252	0.6524	0.2257
17	0.7775	0.5170	0.6589	0.2293
18	0.7959	0.5628	0.6627	0.2387
19	0.8208	0.6060	0.6547	0.2451
20	0.8182	0.6101	0.6730	0.2544
21	0.7749	0.5844	0.6569	0.2569
22	0.7670	0.5847	0.6245	0.2413
MEAN	0.8052	0.5847	0.6958	0.2597
S.DEV	0.0237	0.0391	0.0353	0.0194

APPENDIX N

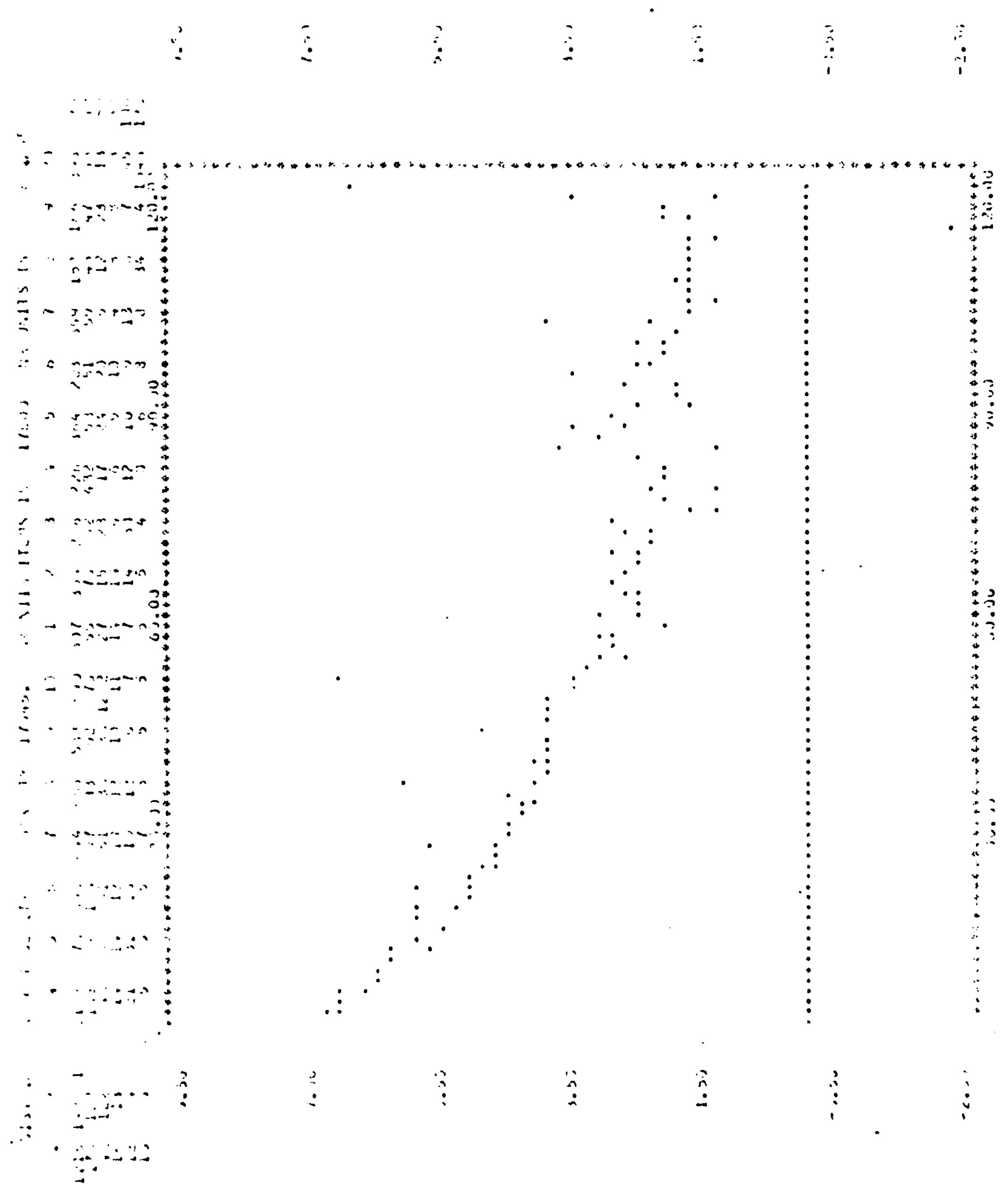
STATISTICS FOR UNIT EFFECTIVENESS MODEL, $\lambda = .154$

TRSLL LOAD LIST OUTPUT STATISTICS

LE = 0.154 LN = 0.154 T = 1.0 K13 = 1.

		NLN	ER	TOTAL
CANDIDATES		14557	139691	154253
LL RANGE		3354	14438	17792
LL VALUE		726411.	376417.	1102828.
ADDS TO LL		3354	14438	17792
ADDS VALUE		726411.	376417.	1102828.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		0	0	0
CONSTRAINED QTY		0	1315	1315
EFFECTIVENESS DATA				
UNITS SAT		149533.	74923.	224451.
REQN SAT		2906.	19677.	22583.
DMD	LL	152721.	73794.	231515.
	NLL	30465.	16734.	47200.
	ALL			278715.
FREQ	LL	3197.	21859.	25057.
	NLL	2091.	2369.	4460.
	ALL			29515.
NET UNIT EFF		0.9792	0.9509	0.9595
GROSS UNIT EFF		0.8153	0.7843	0.8053
NET REQN EFF		0.9058	0.9002	0.9010
GROSS REQN EFF		0.5494	0.8122	0.7551
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	3554	5295	8849
	NLL	10129	7895	18024
	ALL			26873
BRF X POP	LL	0	9143	9143
	NLL	0	104191	104191
	ALL			113334
FORCED POST	LL	0	0	0
	NLL	1084	13167	14251
	ALL			14251
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	0	3	3
	NLL	1131	5369	5500
	ALL			5503
MIN RISK	LL	1451	5554	7005
	NLL	0	0	0
	ALL			7005
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR UNIT EFFECTIVENESS MODEL, $\lambda = .154$



STATISTICS FOR UNIT EFFECTIVENESS MODEL, $\lambda = .154$

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REQN	GROSS REQN
1	0.8682	0.6435	0.8735	0.4496
2	0.8764	0.6593	0.8465	0.4364
3	0.8837	0.6712	0.8427	0.4469
4	0.8633	0.6748	0.8371	0.4659
5	0.8876	0.7016	0.8360	0.4722
6	0.8637	0.6756	0.8334	0.4623
7	0.8590	0.6698	0.8316	0.4568
8	0.8667	0.7075	0.8639	0.4770
9	0.8568	0.7021	0.8625	0.4553
10	0.8400	0.6279	0.8469	0.4296
11	0.8221	0.5859	0.8314	0.4151
12	0.8174	0.5868	0.8285	0.4171
13	0.8514	0.6598	0.8248	0.4152
14	0.8205	0.6148	0.7963	0.3901
15	0.8287	0.5662	0.7813	0.3668
16	0.8137	0.5671	0.7770	0.3604
17	0.8110	0.5576	0.7698	0.3526
18	0.8292	0.6243	0.7670	0.3545
19	0.8550	0.6483	0.7751	0.3660
20	0.8541	0.6544	0.7865	0.3796
21	0.8110	0.6287	0.7698	0.3827
22	0.8021	0.6316	0.7335	0.3654
MEAN	0.8446	0.6390	0.8143	0.4144
S.DEV	0.0260	0.0448	0.0386	0.0430

APPENDIX O

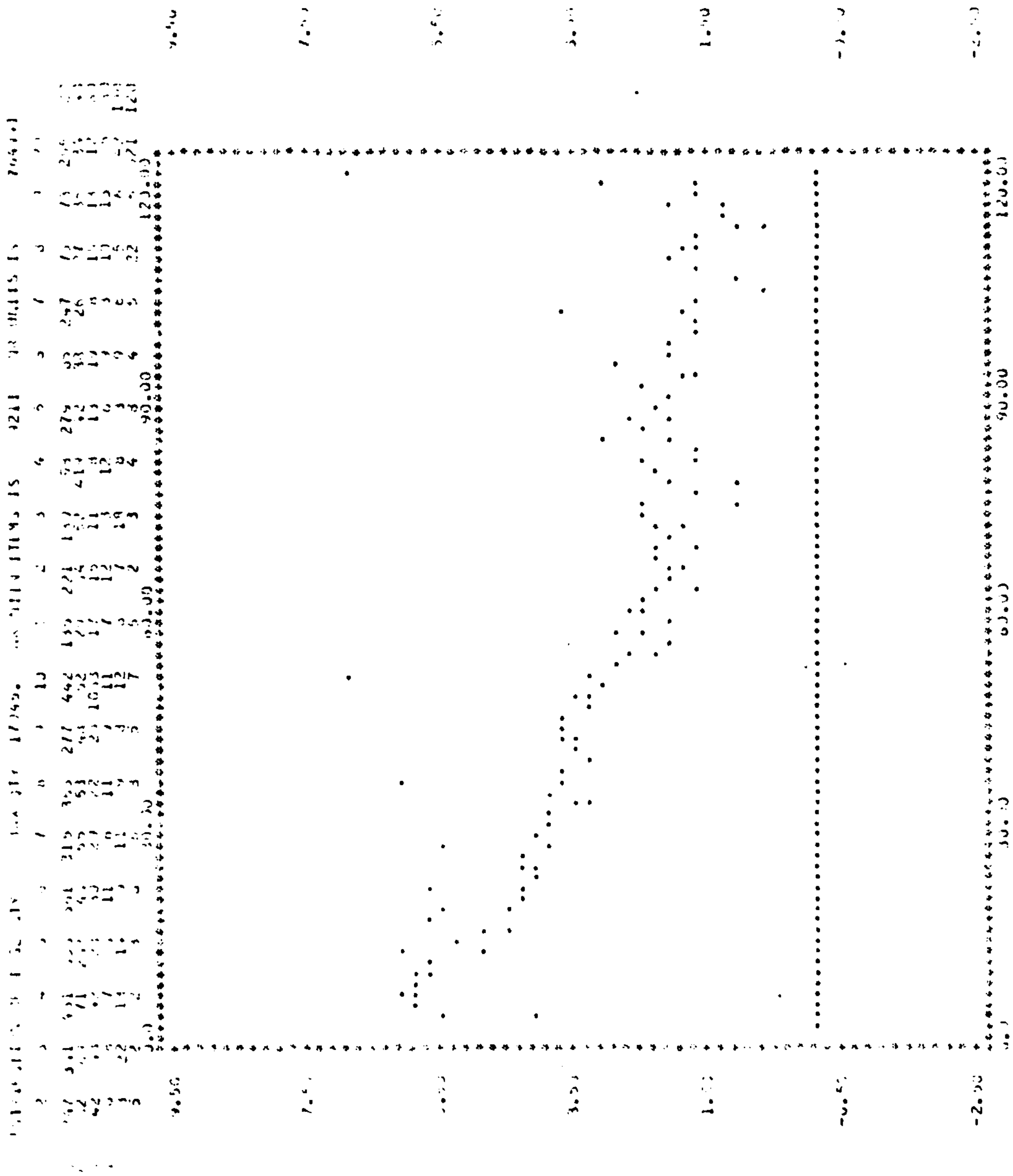
STATISTICS FOR UNIT EFFECTIVENESS MODEL, $\lambda = 2.10$

TRSLL LOAD LIST OUTPUT STATISTICS

LE = 2.100 LN = 2.100 T = 1.0 K13 = 1.

		NER	ER	TOTAL
CANDIDATES		14567	139691	154258
LL RANGE		1857	7414	9271
LL VALUE		324772.	140833.	465605.
ADDS TO LL		1857	7414	9271
ADDS VALUE		324772.	140833.	465605.
DELETES FM LL		0	0	0
DELETES VALUE		0.	0.	0.
FORCED ON LL		0	0	0
CONSTRAINED QTY		0	914	914
EFFECTIVENESS DATA				
UNITS SAT		139677.	62285.	201962.
REQN SAT		1697.	12603.	14300.
DMD	LL	145348.	68276.	213624.
	NLL	37838.	33686.	71524.
	ALL			285148.
FREQ	LL	2063.	15650.	17713.
	NLL	3225.	3912.	7137.
	ALL			24850.
NET UNIT EFF		0.9610	0.9123	0.9454
GROSS UNIT EFF		0.7625	0.6109	0.7083
NET REQN EFF		0.8225	0.8053	0.8073
GROSS REQN EFF		0.3209	0.6443	0.5755
AVERAGE DEMAND COMPUTATION				
HISTORICAL DMD	LL	1357	2961	4318
	NLL	11626	10229	21855
	ALL			26173
BRF X POP	LL	0	4453	4453
	NLL	0	108881	108881
	ALL			113334
FORCED FCST	LL	0	0	0
	NLL	1084	13167	14251
	ALL			14251
NUMBER OF ITEMS RISK CONSTRAINED				
MAX RISK	LL	6	17	23
	NLL	2615	12437	15052
	ALL			15075
MIN RISK	LL	527	1465	1992
	NLL	0	0	0
	ALL			1992
OVERRIDES APPLIED				
MANDATORY		0	0	0
MAX QTY		0	0	0
MIN QTY		0	0	0
DELETE		0	0	0

STATISTICS FOR UNIT EFFECTIVENESS MODEL, λ=2.10



STATISTICS FOR UNIT EFFECTIVENESS MODEL, λ=2.10

LOAD LIST EFFECTIVENESS ATLANTIC FLEET

QTR	NET UNIT	GROSS UNIT	NET REQM	GROSS REQM
1	0.3723	0.5921	0.8032	0.2736
2	0.3743	0.5123	0.7948	0.2571
3	0.3351	0.5260	0.7346	0.2794
4	0.3503	0.5325	0.7345	0.2351
5	0.3328	0.6615	0.8057	0.2024
6	0.3555	0.5540	0.7936	0.2492
7	0.3493	0.6334	0.8073	0.2370
8	0.3353	0.5724	0.8252	0.3022
9	0.3403	0.5527	0.8175	0.2501
10	0.3232	0.5592	0.8123	0.2610
11	0.3105	0.5463	0.7384	0.2431
12	0.3034	0.5527	0.7955	0.2573
13	0.3404	0.5203	0.7953	0.2536
14	0.3152	0.5777	0.7525	0.2372
15	0.3257	0.5303	0.7452	0.2153
16	0.3154	0.5053	0.7553	0.2135
17	0.3114	0.5233	0.7479	0.2180
18	0.3253	0.5927	0.7425	0.2143
19	0.3542	0.5174	0.7413	0.2134
20	0.3552	0.6255	0.7533	0.2242
21	0.3374	0.5938	0.7426	0.2365
22	0.3207	0.5921	0.7146	0.2232
MEAN	0.3405	0.5018	0.7790	0.2554
S.DEV	0.0253	0.0431	0.0313	0.0312

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